SECRET

25X1

SECRET

Sanitized Copy Approved for Release 2011/05/03 : CIA-RDP78B04747A000800010009-4

SECRET

25X1

Preliminary Copy Not Complete.

Report No. 105-65-1
30 January 1965

# FINAL REPORT FOR THE STUDY PHASE I

## PROJECT 105

This document contains information affecting the National Defense of the United States within the meaning of the Espionage Laws, Title 18, U. S. C., Sections 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

Prepared by: ____________________
The Technical Staff of the
Data Processing Section
Under the Supervision of

25X1

Approved by: [redacted]

25X1

Approved by

Director of Engineering

COPY NO. 1

LOG NO. 105-64-34

SECRET

Sanitized Copy Approved for Release 2011/05/03 : CIA-RDP78B04747A000800010009-4

Page Denied

25X1

Final Report Of Phase 1
Program 105
30 January 1965

## SECTION 1

## INTRODUCTION

This report brings to a conclusion  25X1
effort on Phase 1 of Program 105. Submitted herein are the basic and detailed design goals which are now submitted for evaluation and approval in accordance with this contract.

Many of these design considerations, where we found it necessary have been evaluated by actual breadboarding. In all cases, the design submitted has received extensive consideration and evaluation as the body of this report will show.

The design concept from the beginning has been to produce the most advanced, structurally sound, maintenance free unit possible.

The intent has also been to construct as automatic a unit with the minimum amount of operator controls possible. Yet maintaining these manual inputs which might be necessary.

Constant effort has been expended to meet all requirements of the original RFQ without deviation, and where possible, to improve these design objects without increase in overall cost.

We have produced a rather lengthy report because completeness demanded it.  considers this the completion of Phase 1. How- 25X1
ever, if additional information is required,  will furnish it on 25X1
request.

# SECTION 2

## SCOPE OF INVESTIGATION

This report concludes the effort of Phase 1 of Program 105. The primary concept was to carry this report and existing breadboards to the point where we could prove feasibility and guarantee as far as possible firm prices for a follow-on construction in Phase II.

Like any report of this type an investigation no matter how extensive, is somewhat limited depending upon both time, finances, and problems encountered. No matter how complete or thorough this may be done and with each problem answered, a few more are always generated. The intention, therefore, has been to carry this as far as possible and to report it as completely as we are able. Because of the necessity of a numerous number of people writing a report such as this, some repetition is necessary. We have also tried to present wherever possible, the past history of the evolution of this unit, not only to show why we chose the method we did, but also to show why others are not feasible because of design parameters or space allocation.

This investigation reported herein should show the overall configuration, the control panel, the logic behind the data inputs, the resultant method of accomplishing outputs along with the system's concept which has been generated for the overall unit.

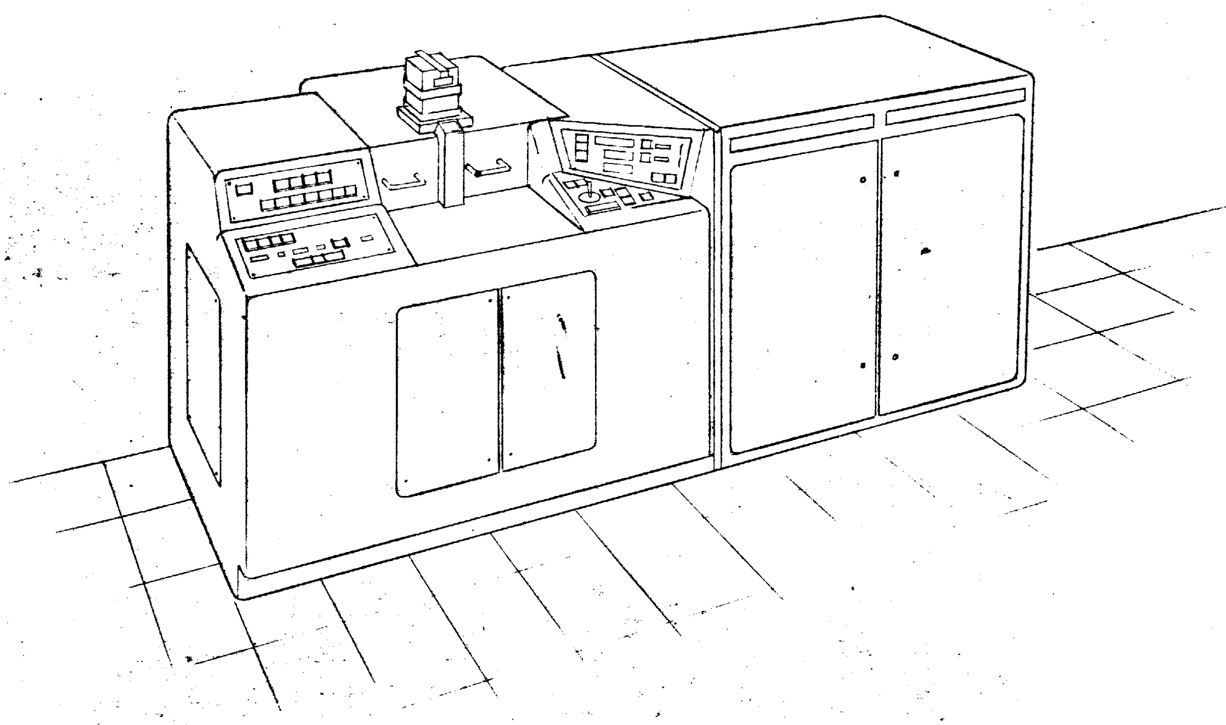


FIGURE 1. PRINT AND ELECTRONICS CONSOLE

Sanitized Copy Approved for Release 2011/05/03 : CIA-RDP78B04747A000800010009-4

## SECTION 3

## SYSTEM ACCURACIES AS DETERMINED BY BREADBOARD AND STUDY RESULTS

The original specification called for an accuracy of 1.0 mm per 15 inches of travel in positioning the film, but it was requested that an effort be made to attempt to achieve a much higher accuracy, which would be in the order of 0.1 mm. This effort was made, and it was found that an accuracy of 0.3 mm could be achieved with good servo stability, over the entire length of the film. This accuracy can be achieved in both the X and Y axes, while the accuracy in azimuth is 0.1 degree.

There are indications from the study of the servo that with further refinements, it might be possible to increase the accuracy to 0.1mm and still maintain good stability. However, this must be observed experimentally before it can be guaranteed.

25X1



## SECTION 4

## CONCLUSIONS AND LIMITATIONS OF DESIGN STUDIES

In order to keep this report from expanding to tremendous bounds, very few calculations have been presented within this report. However, the results of those that are pertinent have been included. Conclusions arrived at in each individual section are discussed separately, and for the most part, are illustrated in the various figures which represent detailed layouts which as far as possible adhering to the actual design the unit is expected to become.

However, as this is a design study and not a finished design, certain areas are subject to minute changes which will be manifested by the evolution of the unit. As design progresses, it is anticipated that these changes will be small and overall it will probably be unnoticeable. Unfortunately there is no exact time when these changes will be known, if any, as these will only be firm with the completion of the constructed item.

Certain areas such as the control panel are examples of this. These panels are illustrated not to present the final configuration, but only that configuration which at the moment appears reasonable from a human engineering, operational standpoint. It is obvious to us here that although we have given a good deal of consideration to factors such as this, that an actual operator might have considerations or requirements which may make for small changes and these can only be ironed out by discussions with the contractor.

25X1



There are a few areas where we have lacked information which must be supplied to us before the design can be firmed up completely. In all cases, these have been asked for and where we have not received them, we have taken our best guess, these items will be necessary before the final design can be completed.

25X1



# SECTION 5

# OVERALL SYSTEM CONCEPT

## 5.1 System Description And Basic System Flow

The Chip Printer Unit can be divided into the following stations:

- Input Stations
- Printout Station
- Film Positioning Station
- Chip Handling Station
- Program Control Station

As can be seen in Figure 2, the input data is presented to the Chip Printer by means of a paper tape. The format of this paper tape is described in Section 5.2 of this report. If the operator does not have a paper tape for a given target, he prepares an input tape, off-line on a teletype unit, and then operates from this tape. The operator could punch in this information directly into the Chip Printer unit, but it is not a recommended procedure of operation.

The leading portion of the input tape is control information for the Chip Printer. The operator pushes the reset button and then starts the paper tape reader. The reset button places all of the logic and control circuitry into its starting phase. When the data appears, the different portions of data are distributed by the input switching station into the proper areas. The servo information proceeds to the servo controls, the number of chips and classification are placed into the program control unit and the accession number is placed into the accession number generator. The input tape is checked both for vertical and longitudinal parity errors.

The Chip Printer is designed so after that the Y servo position is read in and is being positioned to the proper number, the input tape is halted. After the Y axis has been positioned, a signal automatically starts the paper tape reader again and reads the azimuth position. The paper tape reader will then halt. After the azimuth position has been set, a signal automatically restarts the paper tape reader and places it in the X position. The X position remains in the servo control so that as the chips are being printed and some displacement occurs in the X axis, the servo automatically returns the film to the proper location. After the Y, azimuth and X inputs have been positioned, the input tape feeds in data required by the program control unit and then stops. A light flashes on the instrument panel indicating that the servo is positioned properly. The operator can view the located position and be certain that it is the point that he is required to copy. He then moves the film chip cassette into position for making chip copies. Once the cassette is in place, he presses the print button which starts the paper tape reader.

This start-stop system was decided upon to avoid tremendous storage logic.

Input -
1- Y
2- Az
3- X
in this order

The second part of the information on the tape is the accession number which is reproduced on the output chip copy. The design of the switching circuit and the accession number generator is such that the machine code and the alphabetical display can be generated from the input code. The output machine code is an American standard code, but it is somewhat modified with respect to the input configuration. Whereas, the input code is 8 levels, the output appears with 9 levels. The 9th level is a timing pulse which is placed into the 5th position of the output machine code. This displaces the 5th, 6th, 7th, and 8th characters of the input code. The input and output are an even parity. The output code may appear to be odd parity since the timing pulse will always be present. This pulse is not considered as reference data, but only a means of facilitating easy reading of the output data block so that the output is truly in even parity form.

The program control unit which receives information by tape as to the number of prints required and their classification, can also receive this information manually. If at any time the operator wishes, to increase the number of copies, he presses the manual input button and inserts by input switches, the new required number. This overrides any input information as received on paper tape. The same is true for the classification, the operator can override any tape input information by means of a manual control. The program control unit would then regulate the chip printing operation by monitoring operations that occur in the automatic control circuit, the chip movement circuit, and the accession number generation circuit.

Once the required number of prints have been made, the Chip Printer unit resets itself automatically such that the next input request operates in like manner as described above.

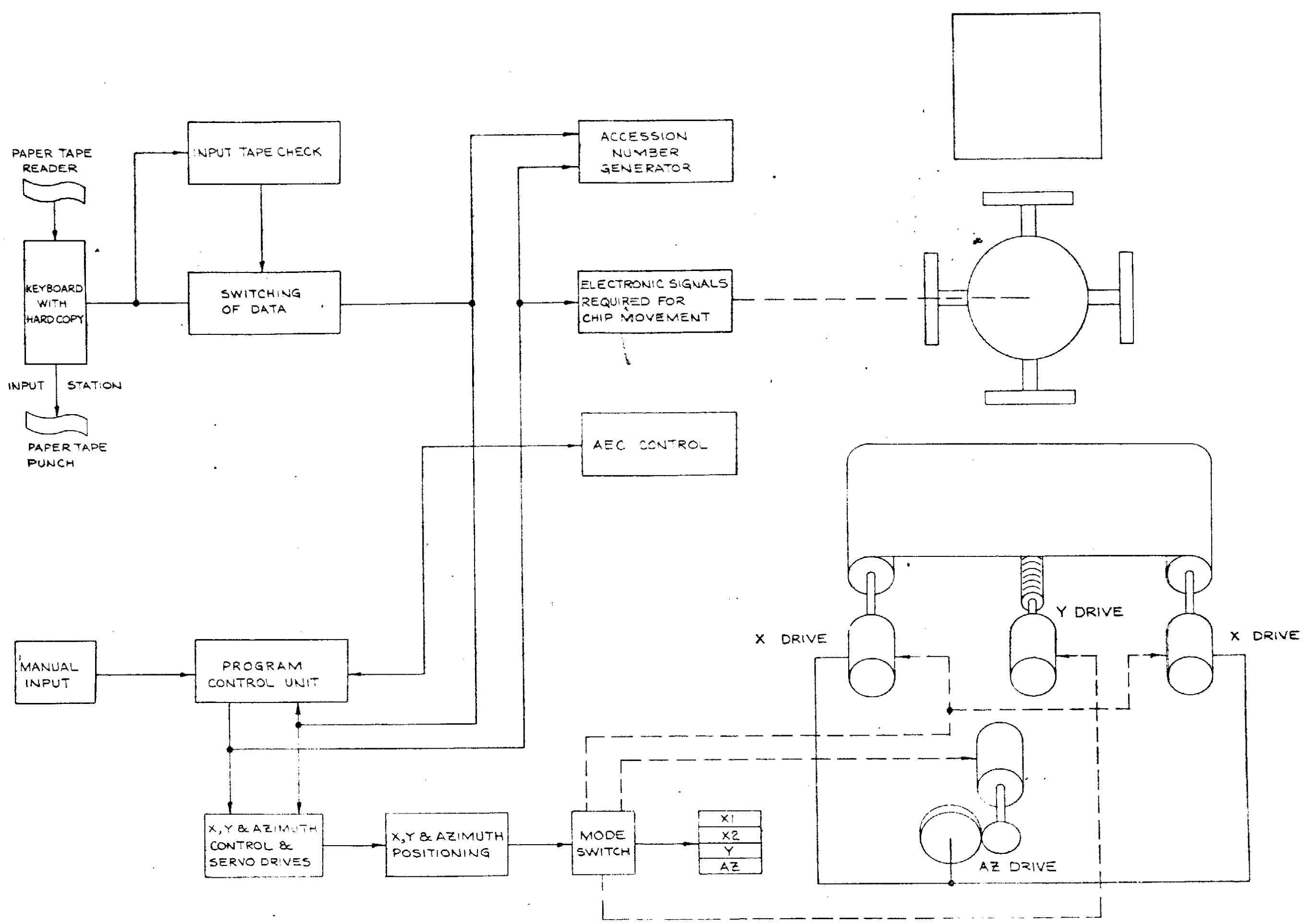



FIGURE 2. SIMPLIFIED SYSTEM BLOCK DIAGRAM

## 5.2 SYSTEM INPUTS AND OUTPUTS

### 5.2.1 Paper Tape Input Format

In order to simplify the input circuitry of the chip printer, and also to be able to present the accession number in any possible order, it is planned that the input tape be preceded by the information required to operate the chip printer, then followed by the accession number. In this way the information in the accession number need not be finalized at this date and may be changed at any time without effecting any circuits in the Chip Printer Unit. The following is the format that will be used for the paper tape input.

| Message Position | Message Symbol | Description |
|---|---|---|
| 1 | $S_7$ | Information Separator |
| 2 | Plus or Minus | Sign of Y Position |
| 3 | Number | Most Significant Digit (MSD) of Y |
| 4 | Number | Second MSD of Y |
| 5 | Number | Third MSD of Y |
| 6 | Number | LSD of Y |
| 7 | $S_7$ | Information Separator |
| 8 | Number | MSD of Azimuth Position |
| 9 | Number | Second MSD of Azimuth |

 25X1

| Message Position | Message Symbol | Description |
|---|---|---|
| 10 | Number | Third MSD of Azimuth |
| 11 | Number | LSC of Azimuth |
| 12 | $S_7$ | Information Separator |
| 13 | Plus or Minus | Sign of X |
| 14 | Number | MSD of X |
| 15 | Number | Second MSD of X |
| 16 | Number | Third MSD of X |
| 17 | Number | LSC of X |
| 18 | $S_7$ | Information Separator |
| 19 | Number | MSD of the Number that Represents a Security Class |
| 20 | Number | LSD of the Number that Represents a Security Class |
| 21 | $S_7$ | Information Separator |
| 22 | Number | MSD of the Number of Prints |
| 23 | Number | LSD of the Number of Prints |
| 24 | CR | Carriage Return |




Sanitized Copy Approved for Release 2011/05/03 : CIA-RDP78B04747A000800010009-4

 25X1

| Message Position | Message Symbol | Description |
|---|---|---|
| 25 | LF | Line Feed |
| 26 | SOM | Start of Message |
| 27 to 82 | Alpha Numeric | 56 Position Accession Number |
| 83 | CR | Carriage Return |
| 84 | LF | Line Feed |
| 85 up to 152 | Alpha Numeric | Up to 68 Machine Readable Codes Only |
| 153 | $S_7$ | Information Separator |
| 154 | Number | MPC Parity Check |
| 155 | Number | MPC Parity Check |
| 156 | EOT | End of Transmission |

The first 25 positions on the input tape are used to control the Chip Printer. The 27th to the 82nd character (56 Alpha-numeric characters) are printed in human readable form on the output film chip. The 26th to the 82nd are printed in machine readable form. The 83rd and 84th characters are not printed but they are used to control the teletype unit. From tape position number 85 on to position 152 (a maximum of 68 characters) the user may add machine readable dodes only. If the user puts in a full 68 characters, then the 153rd character would be an information separator ($S_7$) symbol. This character is not printed out on the output film. The 154th and 155th characters are the MPC parity check sum, which is printed out. The 156th character is the End of Transmission symbol,

 25X1

which is also printed out. If the user had decided not to use the full 68 machine readable characters, then the tape position following the last character used would be the Information Separator symbol (which is not printed out) followed by the two (2) MPC parity checks and the End of Transmission symbol. The American Standard Code, as shown in Table 1 is used with an even parity conversion.

The Teletype, Model 35AW, which has two sprocket feed paper tape readers beside the paper tape punch and the hard copy print out is the input device. This unit has an output of character parallel and it will have separate punch and reader operator controls.

Film Positioning

The X position will have a plus or minus sign conversion, which will indicate positive (+) going to the right of the fiducial and negative (-) going to the left of the fiducial. The Y value will be measured negative (-) going down from the top fiducial and positive (+) measuring up from the lower fiducial. When working with the 5 inch or 70mm two channel condition, it will be the responsibility of the operator to position the chip magazine over the proper channel and to the proper upper or lower fiducial, then press a button to indicate which channel the measurement will be made on. If two measurements are to be made on the same frame using the same starting fiducial, then the operator would continue his operation without having to reset his counters or realign his starting point.

Output Format

The output chip will have the format as shown in Figure 4. The printing density will be 2 machine codes for each character printed. The chip could have up to 56 alphanumeric characters and up to 123 machine code characters in its maximum configuration.

 25X1

## 5.3 BLOCK DIAGRAM AND SYSTEM DESCRIPTION OF INPUT FUNCTION

Figure 3 will be used as a guide to explain the input station function. As stated in Section 5.1, the input station's main function is:

- Switch the input information into the appropriate areas.

- Perform parity checks, both in vertical rows and in longitudinal columns.

- Regulate the data such that the required output character generation is made to the desired output format.

As was stated in Section 5.2, the input information is arranged on the tape so that the Item Separators are used to separate each piece of information. The input station will have an Item Separator Counter which keeps track of the Item Separators that have entered the system. This function is performed by having the code for the Item Separator stored as one input to an AND gate. A second input to this AND gate is the input tape. When the Item Separator is detected coincidence occurs and a signal is sent to the Item Separator Counter which then prepares the system for the first block of information.

The first Item Separator output passes through a time delay circuit and places flip-flop 1 into the set position. The output of flip-flop 1 enables the input AND gate to allow information to pass through gate 1, controlled by flip-flop 1 to gate 2. Gate 2 has already been placed into the reset position which allows the signal to pass through gate 2 and then into the servo control unit. The servo control unit then operates on the first four lines of data input which represents

25X1

the Y axis position. When the second Item Separator is read, an output from the Item Separator Counter then stops the paper tape reader. The paper tape reader is not started again until it has received a servo operation complete signal from the servo unit. Simultaneously, with the entry of the first four lines of data, a vertical parity check is made on each character, and a tabulation of the longitudinal parity is made by entering data into a 9 flip-flop storage. If a parity error occurs, operation stops and the parity error light appears.

After the paper tape has been started by the servo operation complete signal, the second four lines of data are presented to the servo unit by the same method as described for the previous four lines of data. When this second block of information (azimuth position) is read in, the third Item Separator stops the paper tape reader. After the azimuth position is completed, the servo operation complete signal restarts the paper tape reader and reads the next block of data, (X) position, into the servo unit. The reading of the fourth Item Separator stops the paper tape reader and also sets flip-flop 2 so that the next block of input data is placed into the control unit. The first, second and third Item Separator output signals are used also to control the servo switching circuit. This circuit allows the time sharing of the same decoding of the input information and the comparison to the output information to be used on all three axes. Each servo axis has its own amplifier drive motor, drive motor, and shaft encoder feed back, but they all share the same comparator circuit by means of the servo switching operation.

The data following the fourth Item Separator is presented to gate 3 which is in a reset position and, therefore, allows the data to be stored in the classification area. After the two digit classification has been read in, the fifth Item Separator switches the flip-flop 3

25X1

into the set position and allow the next two lines of data to be placed into the number of print area.

This completes storing of information required to operate the chip printer. The chip printer now flashes on a light that the servos have positioned and everything is ready for the next operation. After the operator has satisfied himself that the copy film has been positioned properly, he presses the print button. This restarts the paper tape reader. The carriage return symbol is detected by means of the carriage return storage circuitry which forms a coincidence on the input line. This output signal places a count into the AND gate output counter. The first count passes through an OR gate through a time delay unit and sets flip-flop 4 which then allows the first symbol, which is the start of message, to appear in the output generator. The time delay before flip-flop 4 is so regulated that the line feed signal which is required for proper teletype operation does not appear in the output chip. The operation is such that the characters from input tape position 26 through input tape position 82 goes directly into the character generator. The 83rd position is a required carriage return and line feed signal which is needed by the teletype unit due to its limited carriage width. The carriage return signal then forms a coincidence circuit with the carriage return storage and feed a second count into the AND counter. This signal places flip-flop 4 in a reset position until the line feed signal is no longer present and then it resets flip flop 4. In this way input tape positions 85 up to 152 are placed into the output character generator.

Item Separator 6 is then detected by the Item Separator coincidence circuit. The Item Separator counter output signal for Item Separator 6 then places flip-flop 4 in a reset position so that this Item Separator signal is not printed out. Item Separator 6 output signal also places flip-flop 6 into the set position. Once flip-flop 6 has been placed into the set position, the next line of data, which is the MPC parity check signal, can be placed into the MPC storage unit.

This information is also printed out onto the output chip. Once the signal has been presented to the MPC storage unit, the comparator circuit is then activated. The stored MPC number is now compared to the generated vertical parity count. If the comparison circuit indicates one number to be higher or lower than the other, the parity error signal is then initiated and the operations come to a stop.

This completes one operation signal for the input station. All reset circuits are then initiated and the circuit is ready for the next data entry.

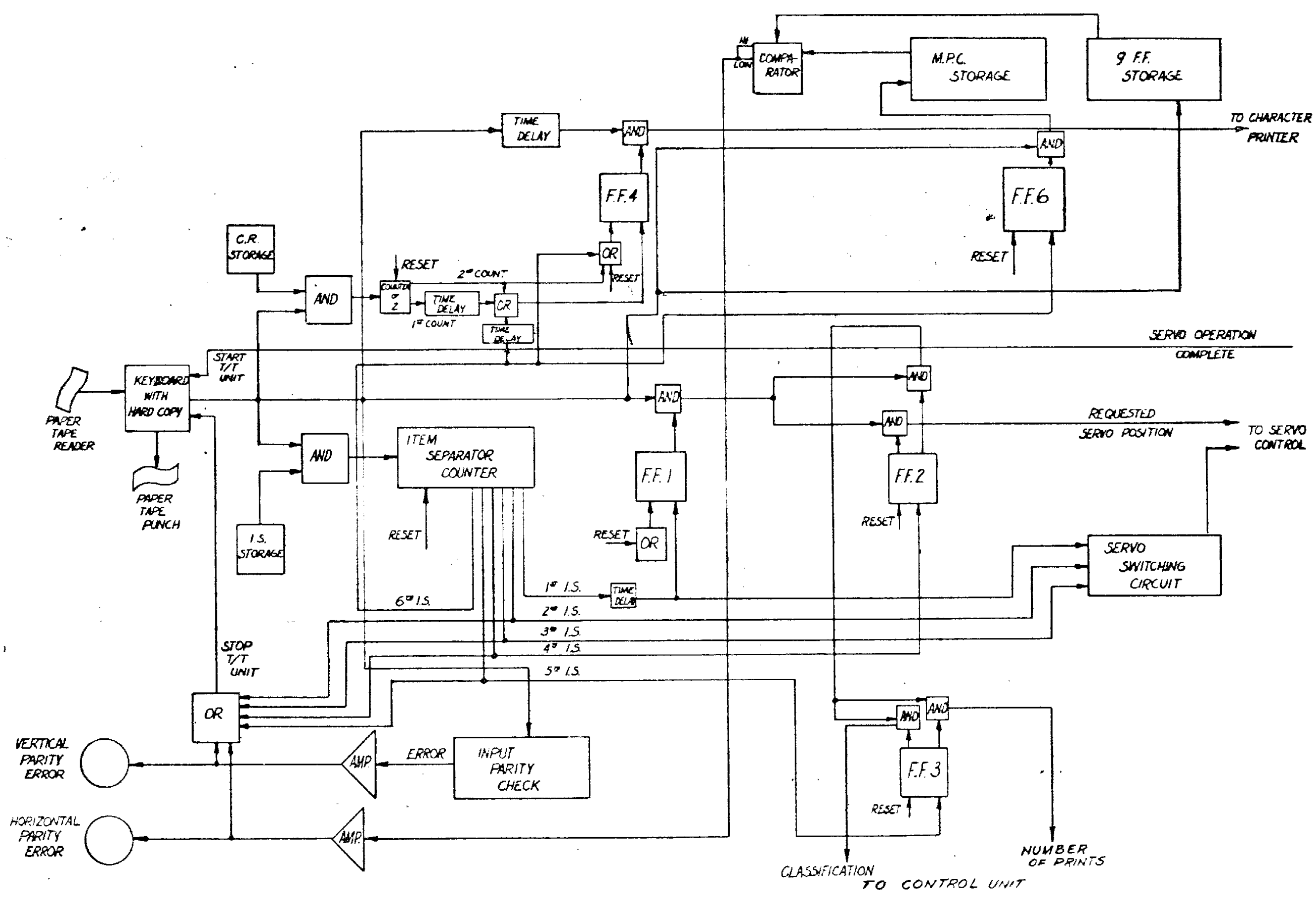



FIGURE 3. INPUT STATION

## 5.4 BLOCK DIAGRAM AND SYSTEM DESCRIPTION OF THE PRINT OUT FUNCTION

Figure 4 is used as an aid in the following description of the data recording function. As described in Section 5.3 (the Input Function) data will be presented to the data recording function at the appropriate time. When the input data comes into the data recording unit, it will be placed into the machine code keys since the same American standard code will be produced as it is received. The only change is in the location of the output bits since the timing pulse has been placed in the center of the character. Since this only requires a wiring change and nothing else, this data can pass directly to the keys and then through a time delay circuit that would strike the hammer to print. This signal will also pass through a second time delay circuit which would synchronize to the character generation with the tape motor drive. The machine code generation operation will be independent to the character generation since the character generation requires "seeking" of the proper letter on the code wheel.

The input data is also placed into a matrix converter. The matrix converter will convert the input information into a two digit number. The reason for this conversion is to simplify the circuitry required to detect the proper letter from the code wheel. The code wheel is arranged such that each letter on the wheel will have an engraving on an adjacent code wheel such that a magnetic pick up head feeding a signal to a counter will store the proper count for the proper letter as the wheel is rotating. A wide pulse is placed on the wheel at the start of the alphabet which will indicate the first position of the wheel. This will be passed through a first count detector circuit and reset the counter for every revolution of the code wheel. The code wheel will rotate at a constant 600 rpm so that the counter will, in turn, reset itself at 600 times a minute. The output of the counter will be placed to one side of the comparator. The second signal to the comparator will be obtained

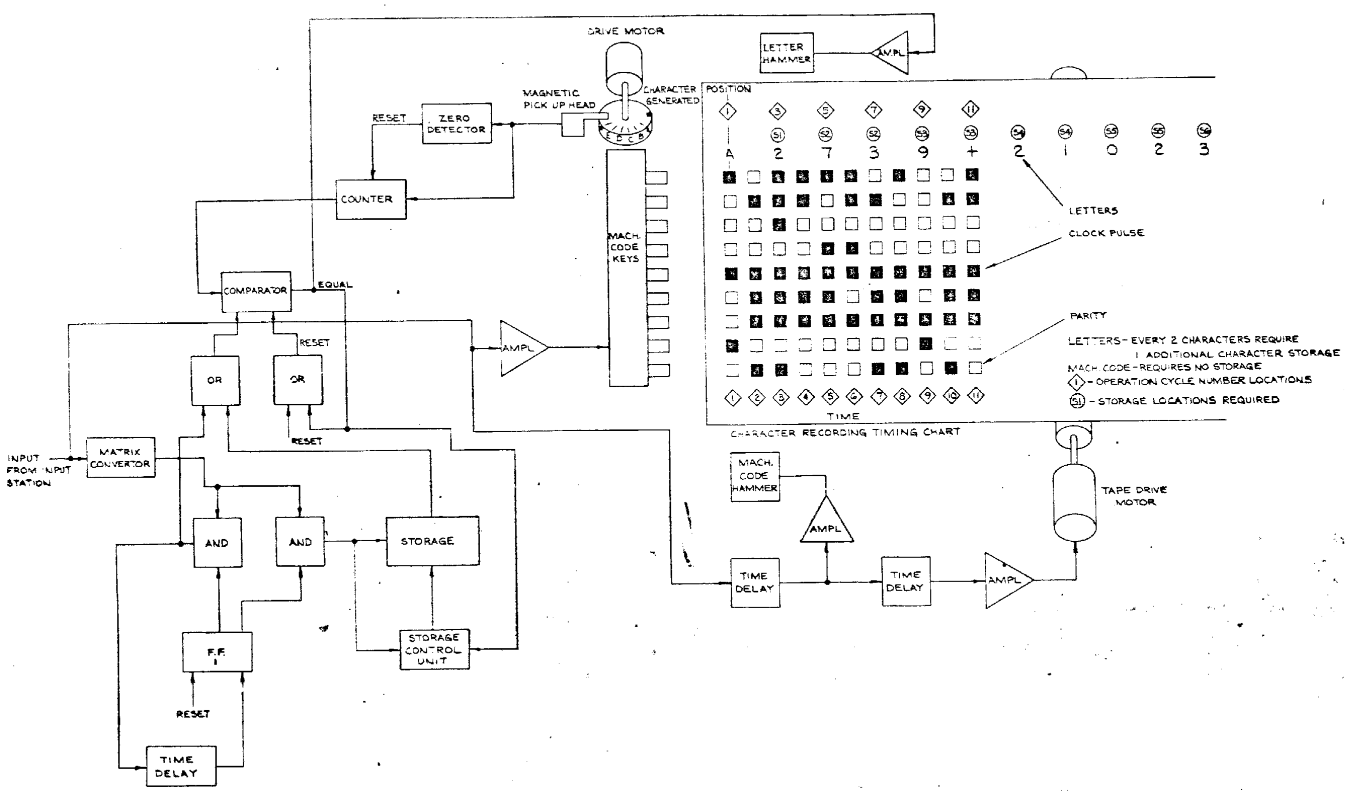



FIGURE 4. DATA RECORDING FUNCTION AND CHARACTER RECORDING TIMING CHART

through some switching circuits from the matrix converter. When the two signals are identical, an equal signal will be presented and will be used to activate the letter hammer so that the proper letter is placed on the Cronapress conversion film.

The reason for the switching circuit on the output of the matrix converter is the following. In order to compact the machine code at a density ratio of 2:1 to the character code, an accumulative amount of storage will be required. In order to properly switch the right character into the comparator, a storage unit is required. Flip-flop 1 starting out in a reset position will allow the first matrix character coming through to be placed directly into the comparator unit. After that signal has been placed into the comparator, it will activate a time delay unit and switch flip-flop 1 into a set position. The next character from the matrix converter will then pass into storage and the storage control circuitry will then place this character into the comparator at the proper time. Then, each subsequent character from the matrix converter will be placed into storage and the storage control unit will arrange them such that the proper character will be presented at the proper time. At the completion of operations all reset circuits will be operated.

There is a detailed explanation of this operation given in Section 6, which will go into detail on the timing required by this equipment in order to function properly.

## 5.5 BLOCK DIAGRAM SYSTEM DESCRIPTION OF THE FILM POSITIONING SERVO FUNCTION

Figure 5 will be used to help describe the servo logic control. As was described in Section 5.3 the appropriate data will be presented to the servo control unit by the Input Station. The first block of information will be that of the Y Axis position. The servo switching unit will then switch over to the Y servo controls. The digital information which indicates the Y position will be placed into the comparator. The present

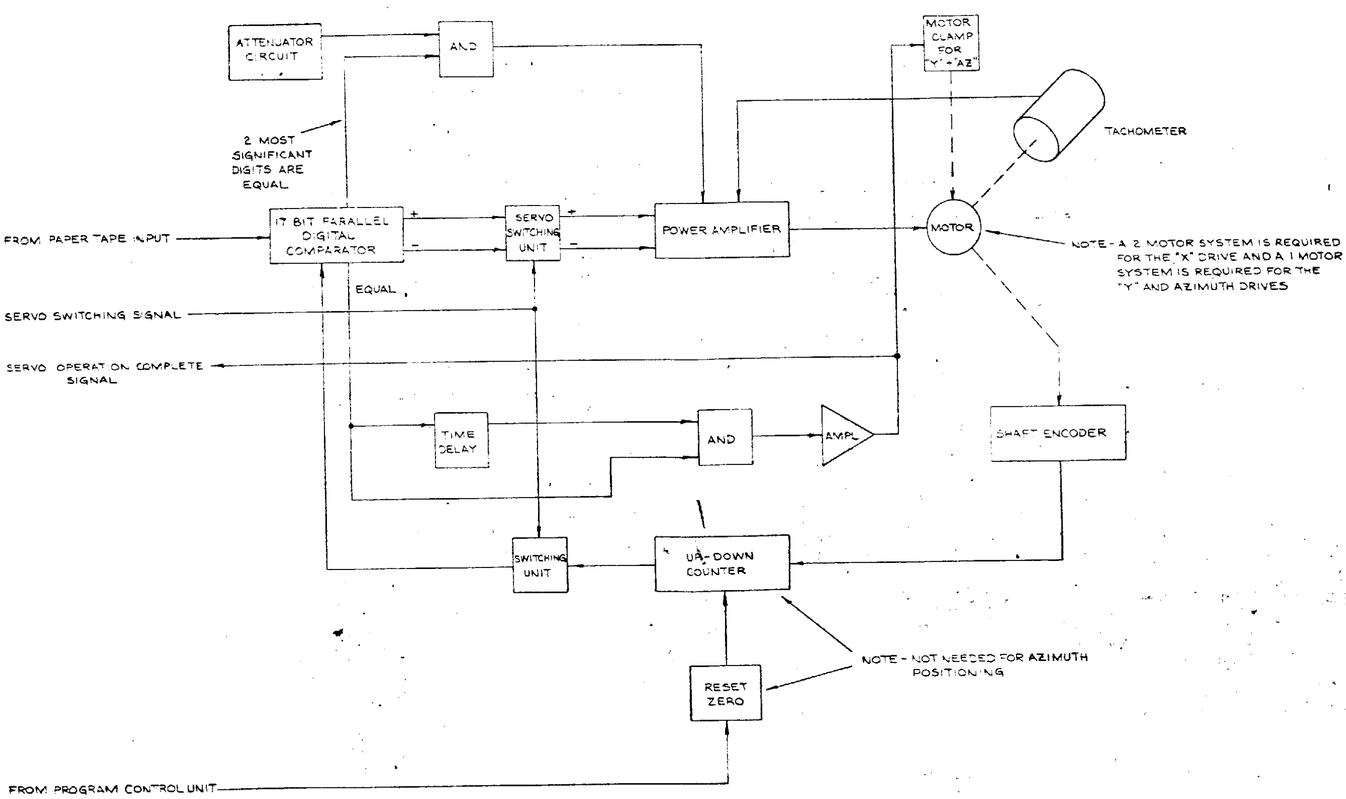



FIGURE 5. SERVO CONTROL LOGIC

shaft encoder position will be placed into the other side of the comparator and the servo unit will drive to the requested position.

The sequence of operation would be that the operator would position the frame that will be used to make reprints. This frame will be positioned under the optical axis of the chip printer. The operator will then press the counter reset button which will then place the Y and X counters to the zero position. When the input information is placed on one side of the comparator, the comparator circuit will indicate if the servo should drive higher or lower in order to have the output number as generated by the incremental shaft encoder and its counter to be equal to the input level. The drive motor will have its own power amplifier and tachometer feed back loop such that the motor will be a constant velocity stabilized drive system. When the comparator has indicated that the two numbers are equal, and equal signal will be sent from the comparator to a time delay circuit which will only activate the AND gate when a sufficient time has passed to ensure the circuit is at the proper location. The output of this AND circuit will then clamp the motor in the Y position. Its signal will also indicate that the servo operation is complete and it will start the paper tape reader such that the next block of data will be entered in the servo control unit.

The second block of data will be that of the azimuth position. The servo switching circuit will then switch the azimuth drive and encoder into the comparator circuit. In the azimuth operation the position will not be re-set to zero but will be an absolute count of where the encoder is positioned at the present time. The present encoder position is compared to the re-quested azimuth position, the error signal will then drive the proper motor in the direction such that the present position will be equal to the desired position. When this occurs an equal signal is sent out which will clamp the motor in the azimuth position and signal to the input station that the servo operation has been completed.

The X position is then read into the comparator circuit. The servo switching unit is placed onto the X servo axis. In the X position two drive motors are required in order to maintain tension on the roll of film. One incremental shaft encoder is used to maintain the position of the X drive. The output of this shaft encoder is fed to an up down counter which will indicate position of the X axis. This information is placed into the digital comparator. If these two numbers are not equal a plus or minus signal is sent to the power amplifier which will drive the proper motor such that the two counts are equal. When the two numbers are equal and "equal" signal will be sent which will indicate only that the servo operation has been completed, but the X location will be left in the digital comparator such that any displacement of film in the X direction will automatically be compensated for once the displacement force has been released.

The digital comparator will also have a circuit which will allow the X, Y and azimuth servo to slow down once the first two most significant digits are equal. This is needed to help stabilized the servo as it approaches the null position. The two most significant digits will allow the film to be moved at a very high rate of speed when we are away from null, and slow down as we approach it. A more complete and detailed explanation of the servo operation can be found in Sections 7 and 8 of this report.

## 5.6 BLOCK DIAGRAM AND SYSTEM DESCRIPTION OF THE AUTOMATIC EXPOSURE CONTROL, THE CHIP HANDLING FUNCTION AND THE PROGRAM CONTROL UNIT

### 5.6.1 The Automatic Exposure Control

It is the purpose of this section to explain the principle of Automatic Exposure Control to be employed, in accordance with requirements as outlined in specifications and revisions thereof.

— Requirements

The Exposure Control shall be capable of automatically or manually controlling an electronic timer for producing contact prints of optimum density from processed film ranging in average scene density from 0.1 through 3. The exposure system shall accommodate for either of two modes of operation for sensing the film scene brightness as follows:

1. To sense by direct light transmittance through the film to be printed, a fixed area of the format.

2. To sense through an optical system, a smaller portion of the fixed area.

— Discussion

The initial concept for automatic exposure control was predicated upon the probable necessity for a memory device. This permits the sampling of film scene brightness, in order to produce a control voltage. This voltage will be given to the timer that will retain it for any desired number of print reproductions. It is, therefore, only necessary to sample the brightness from any one film format but once. To provide this feature, the resultant current signal from the light sensor positions a dual section potentiometer via a servomechanism. The current signal is nulled out by means of a reference voltage across one potentiometer section, as the signal from its wiper matches that from the light sensor. A small trimpot in series with the potentiometer permits calibration; that is, altering the servo position for a specific reference film density. This calibration is obtained with a neutral density filter, whereby all voltages are maintained constant (via regulation) including the light source.

The second potentiometer section furnishes the voltage to the exposure timer. This potentiometer is provided with two adjustable trimpots, one at each end winding terminal. These trimpots provide a slope adjustment to compensate for the sensor characteristic. Non-linearity of the sensor may be further corrected by a fixed loading from the potentiometer wiper to the voltage source return. The curve may be shifted either up or down depending upon requirements. This may be accomplished by returning the load to the proper side of the source voltage.

While this servo concept for automatic density control appears somewhat elaborate, its flexibility affords adjustments for hair-line accuracy not obtainable with other systems. It further possesses the inherent feature of retaining any brightness level signal, by inhibiting the servo, subsequent to sampling.

The light sensor intended for this control system is a microminiature photo voltaic silicon solar cell. It is glass encapsulated and hermetically sealed, having physical dimensions of .080" diameter by 0.5" in length. Its self-generating feature together with low output impedance affords direct matching to a transistor chopper configuration. Where space permits, multiple cells may be employed (parallel connected) for sensing over different areas of a film format, whereby the output signal will be the sum of the resultant currents. Various other configurations are available, however, which can be made compatible with design requirements.

The control concept for optimum density printing and print reproduction is shown in Figure 6, Functional Schematic Diagram. Its function is described thus:

Direct light penetration through a specific area of the film is sensed by photo sensor P1, which produces a resultant current signal. This is with S1 in the position shown in Figure 6, where section "a" is set to "DIRECT". When S1 is switched to "OPTICAL", the light through a smaller portion of the format area is sensed by P2. R1 and R2 are loading resistors of proper values to equalize the signal outputs of P1 and P2, compensating for the difference in light at the two areas. In the optical mode there is provision for observance of the area to be sensed through an eyepiece. To accommodate for this, "b" section of "S1" energizes the print lamp when in "OPTICAL". In either position of S1, the resultant current signal from the respective sensor determines the position of a two section potentiometer, via a servo positioning system. The current signals are modulated, amplified and phase-rectified, where the output drives the servo motor in proper direction to null out the signal. This nulling out is accomplished with the positioning of section 1 potentiometer, across which is a precisely regulated reference (REF) supply. At the nulled out servo position, section 2 potentiometer has driven to a position which furnishes a voltage to the exposure timer for optimum density printing. As the servo positions the potentiometer to a null, S2 opens automatically, (via positioning mechanism) which inhibits the drive motor to retain the potentiometer setting for as many print reproductions as desired.

The exposure timer consists of a solid-state amplifier, whereby receipt of an electrical pulse of brief or sustained time duration closes relay contacts which energize the print lamp for the time interval dependent upon the voltage furnished from section 2 servo potentiometer. The electrical pulse to the exposure time is produced by closure of S3. This closure is automatic, taking place at the proper time during each "print" cycle. The automatic control of density is, therefore, determined by the servo position which, when section 1 of the potentiometer has nulled out the signal from the sensor, section 2 has furnished the proper voltage to obtain optimum density. There are two other contingent constants to be maintained within the exposure timer, either of which affect the time interval. They are the values of "R" and "C" which together form the time constant. Both of these values are, therefore, fixed for automatic density control.

The current requirements for provision to manually change the time interval by discrete changes in print density of 1/2 "stop" increments, is somewhat simplified by the apparent advantage of controlling "R" rather than the control voltage or "C". This permits the use of a step-switch assembly of multiple switch sections where each switch connects a value of "R" to produce the proper time interval. The manual Stop Selector shown in Figure 6 performs this function. The center switch (shown closed) is the position for automatic control. Each switch to the right augments the time interval, corresponding to 1/2 stops in print density. Each switch to the left shortens the time interval by the same time value. The switch assembly is so arranged that whichever switch

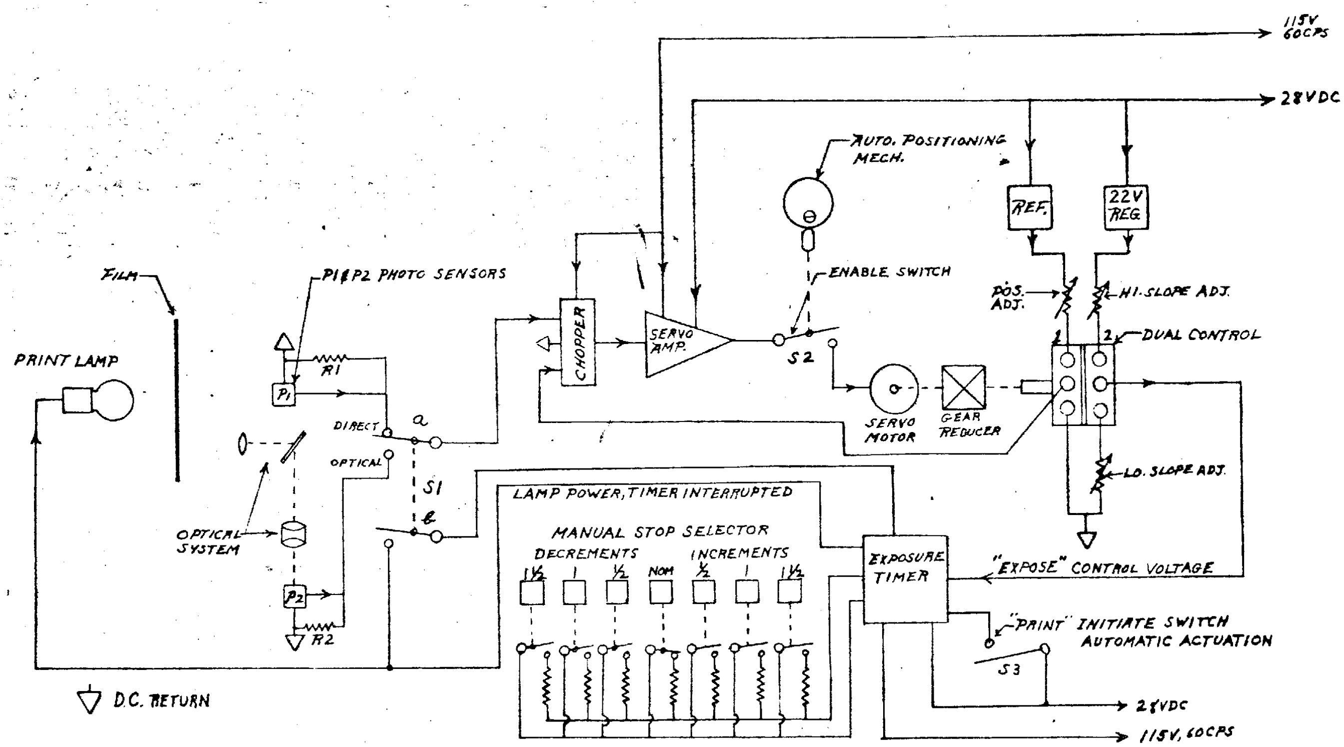



FIGURE 6. EXPOSURE CONTROL CIRCUIT

section is pressed, the previously closed section is open-circuited. In other words, only one switch can ever be closed at a time.

It becomes obvious that the Manual Stop Selector affects only the time interval which, in turn, affects the print density. It has no effect on the position of the servo or the control voltage. It is, therefore, necessary that the operator press the "nominal" switch button prior to sampling a new film, in order to prevent density errors associated with any of the other switch sections.

### 5.6.2 Chip Handling Function

The physical flow concept of the chip handling is illustrated in the block diagram of Figure 7. This system is thoroughly discussed under Section 9.2, "Detailed Operational Description". The major functions of this equipment are, however, covered in this section as summarized below.

a. The operator sets in the desired number of chips for print processing on the Control Panel.

b. An Initiate Switch on the Control Panel is then pressed (momentarily) to start the system into operation.

c. Resultant to pressing the "Initiate Switch", the chip mechanism removes one chip from the cassette. Subsequently, the four platens extend outward to the precise loading position. As this occurs, the chip mechanism places the chip on one of the platens (whichever platen is located at station one).

d. Simultaneous with the loading of the chip which allows vacuum on station one platen only. The time duration for the loading of the chip to the platen is 2.5 seconds.

e. During the 2.5 seconds time that the platens are at the extended, position of the Exposure Control sensor samples the light through the film format to be reproduced. This sampling takes place but once for any one film to be printed.

f. After the 2.5 second time has expired, the platens return to their retracted position. As they attain the fully retracted position, the turret rotates the chip one quadrant, to station two.

g. When turret has rotated 90 degrees, the next subcycle begins. The platens again move to their extended position and the same events take place at station one, that is, chip two is loaded.

h. At station two, however, data is contact printed on chip number 1.

i. The platens again retract and the turret moves chip number 1 to station three. The next subcycle begins.

j. Platens again move to their extended position, where the same events take place at station one, (loading of chip number 3) and station two, data record. During this time, the chip at station three is being exposed. The time of exposure had previously been determined during the sampling of the film.

k. Platens again move to their retracted position and the turret rotates chip number 1 to station four.

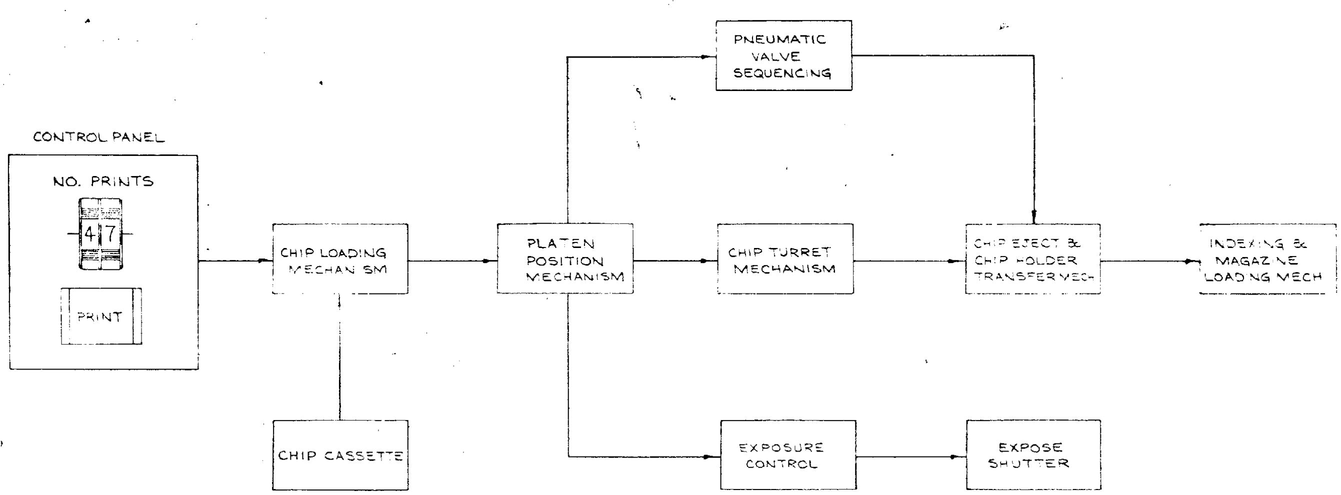



FIGURE 7. CHIP HANDLING - FUNCTIONAL BLOCK DIAGRAM

1. This fourth subcycle completes the "print" processing of the chip. As the platens again extend, chip number 1 is ejected from station four and transferred to the indexing and loading mechanism. It is subsequently taken to an area for development.

The start of a new subcycle continues until the final chip loaded at station one has been rotated through to station four and ejected. The Program Control Unit will control the number of cycles that will occur. When the last cycle has taken place in the system it automatically shuts down in a ready state for a subsequent operational run.

### 5.6.3 Block Diagram and System Description of the Program Control Unit

As described in Section 5.3 the input data will be presented to the program control unit by the input switching circuits. As can be seen in Figure 8, the first data will be two digits that will represent what security classifications the output chip print should have. The second two digits presented will be the number of prints required.

The classification information is stored onto one side of the comparator. The second input to the comparator will be obtained from a photo electric readout code on the classification film. This film has the ability to handle 99 different sets of classification. For system checkout purposes it is envisioned that we will only use 10 classifications on the classification film roll. This classification will be so spaced that it will simultaneously place the classification markings on the upper and lower edge of the film in one exposure. Each classification will have its code marked alongside of it on the edge of the film. A light source will be placed such that a photo electric pickup head will read each code as it passes by. The output of this photo electric reader head will be placed into the comparator. The comparator will then produce an error signal and will drive the motor in a direction that will place the proper classification in position. At the proper operation cycle time this classification will be contact printed onto the output chip.

The number of prints will be placed in a down counter. The output of this counter will be one side of an input to a comparator. The other side of this comparator will have a zero stored in it. When the comparator output is other than equal, a signal will be presented to the chip handling circuit such that a full cycle operation will take place. When this operation has been completed a one cycle operation complete signal will be given to the down counter. This signal will subtract one count from the counter. This new number will now be compared to 0 in the comparator. This cycle of operation will continue until the counter number is equal to 0. When this has happened an equal signal will be generated and an operation complete signal will be given to the chip handling circuit.

Both paper tape input of the security classification selector and the number print input can be overridden manually. This manual input by the operator can allow him, from his operator control panel, to place in a new number for the classification and the number of prints to be made.

The program control unit will also handle such functions as the logic reset and the chip handling magazine alarms. This circuit will also be aware of the cycle position of the chip cassette such that if a failure were to occur, the program control unit will stop the operation of the chip printer and signal the proper alarm indicator.

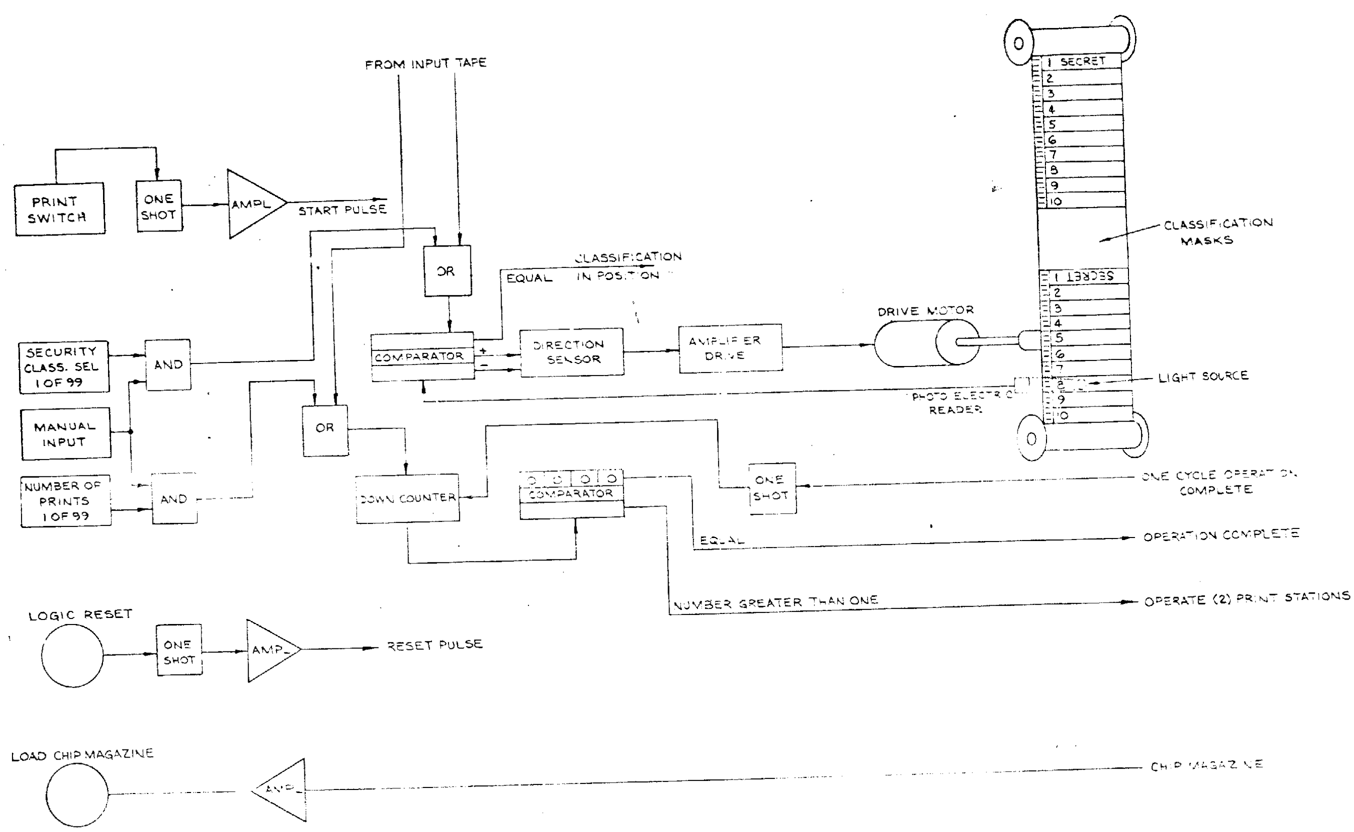



FIGURE 8 PROGRAM CONTROL UNIT - LOGIC DIAGRAM

## 5.7 SAFETY AND ALARM CONTROLS

It is planned to have the electronic portions of the chip printer unit completely resettable. This would mean if, for any reason, the operation was interrupted, the operator would need only to press the master reset button, read in the input paper tape and operations could continue as if it were a new input. Another device to aid the operator in following the chip producing operation would be the parity check. This function is performed on the input tape and will certify that the information on the tape will be properly placed into the chip printer unit. A check will be made on each character in the vertical direction and of the total message in the longitudinal direction. If the input tape passes this test, there should be no doubt that the proper information has been entered into the chip printer unit.

On the front panel is also an indicator which will let the operator know when power is present in the equipment. Also, on the operator's panel is a light which will indicate when the servo operation has been completed. Since the servo might have to travel a long distance for its final location and the rate of slew might be very slow when approaching a null condition, the operator will only know when this light is on when the point has been found. If, for any reason, the servo should fail to stabilize at this point, or find this point, this light will not be lit and the operator will realize that a malfunction has occurred. A more detailed discussion on the Controls and Display can be found in section 10.6 of this report.

## 5.8 STUDIES MADE FOR COMPONENT SELECTIONS

### 5.8.1 Logic Cards

One of the most basic decisions made was that of type logic to be used. As can be seen in Table(2)25 logic cards were studied. The Packard Bell, 200KC, logic cards were selected for the chip printer unit for the following reasons:

- They had pin type connectors and not the printed type connectors which is considered less reliable.

- Two (2) power supply voltages were required and not three (3) supplies as some others used.

- The 3-3/4 x 4-1/4 card size allowed a very compact cabinet design.

- The standard equipment such as card draws, power supplies and chassis rollers were available.

- Proven reliability of this series of cards.

- It is possible to design AND/OR logic, or NAND/NOR logic with the basic cards.

### 5.8.2 Optical Encoders

As can be seen in Tables 3, nine (9) different types of incremental shaft encoders were studied. Five (5) of the encoders studied were of the magnetic type and four (4) of the optical type. Either type encoder is capable of performing the function of positioning the servo. The only difference is which can be made to fit in our design approach easiest. In our approach, we have to be able to reset to zero at any point in the X drive, hence, the requirement for the incremental type shaft encoder. After investigating the different vendors it was decided to use the Wang Laboratories' 1000 count per turn optical encoder. The reasons for using this encoder are as follows:

- The long life that is inherent in an optical encoder.

- The ability to use an already developed counter which would work with the optical encoder.

- The short delivery time which this unit could be obtained.

In order to meet the design requirements of our unit, the shaft encoder counter should be able to count in binary. The counter should have an "on-line" binary output and should be able to convert the binary output information into BCD for display. The display unit will be located remotely from the electronic drive circuitry. Rather than design this unit from the beginning it would be far more desirable if this unit could be purchased, off-the-shelf, already developed. This is the case in this selection since the encoder, counter and display units will be purchased as an "off-the-shelf" package.

### 5.8.3 Input Unit

As can be seen in Table 4, six (6) input units were studied. Of the six (6) input units, the teletype, Model No. 35AW was selected. The customer has shown definite preference towards the teletype unit for compatibility with other equipment. The model No. 35AW is recommended because of its ability to stop on a character, have its output information fed in parallel to the chip printer unit and the ability to remotely start and stop the paper tape reader.




Sanitized Copy Approved for Release 2011/05/03 : CIA-RDP78B04747A000800010009-4

# American Standard Code for Information Interchange

## 1. Scope

This coded character set is to be used for the general interchange of information among information processing systems, communication systems, and associated equipment.

## 2. Standard Code

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $b_7$ | | | | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| $b_6$ | | | | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| $b_5$ | | | | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| $b_4$ | $b_3$ | $b_2$ | $b_1$ | | | | | | | | |
| 0 | 0 | 0 | 0 | NULL | DC$_0$ | ƀ | 0 | @ | P | UNASSIGNED | UNASSIGNED |
| 0 | 0 | 0 | 1 | SOM | DC$_1$ | ! | 1 | A | Q | | |
| 0 | 0 | 1 | 0 | EOA | DC$_2$ | " | 2 | B | R | | |
| 0 | 0 | 1 | 1 | EOM | DC$_3$ | # | 3 | C | S | | |
| 0 | 1 | 0 | 0 | EOT | DC$_4$ (STOP) | $ | 4 | D | T | | |
| 0 | 1 | 0 | 1 | WRU | ERR | % | 5 | E | U | | |
| 0 | 1 | 1 | 0 | RU | SYNC | & | 6 | F | V | | |
| 0 | 1 | 1 | 1 | BELL | LEM | ' (APOS) | 7 | G | W | | |
| 1 | 0 | 0 | 0 | FE$_0$ | S$_0$ | ( | 8 | H | X | | |
| 1 | 0 | 0 | 1 | HT/SK | S$_1$ | ) | 9 | I | Y | | |
| 1 | 0 | 1 | 0 | LF | S$_2$ | * | : | J | Z | | |
| 1 | 0 | 1 | 1 | V$_{TAB}$ | S$_3$ | + | ; | K | [ | | |
| 1 | 1 | 0 | 0 | FF | S$_4$ | , (COMMA) | < | L | \ | | ACK |
| 1 | 1 | 0 | 1 | CR | S$_5$ | − | = | M | ] | | 1 |
| 1 | 1 | 1 | 0 | SO | S$_6$ | . | > | N | ↑ | | ESC |
| 1 | 1 | 1 | 1 | SI | S$_7$ | / | ? | O | ← | | DEL |

## 3. Positional Order and Notation

Standard 7-bit set code positional order and notation are shown below with $b_7$ the high-order, and $b_1$ the low-order, bit position.

| | $b_7$ | $b_6$ | $b_5$ | $b_4$ | $b_3$ | $b_2$ | $b_1$ |
|---|---|---|---|---|---|---|---|
| EXAMPLE: The code for "R" is: | 1 | 0 | 1 | 0 | 0 | 1 | 0 |

## 4. Legend

| | | | |
|---|---|---|---|
| NULL | Null/Idle | DC$_1$-DC$_3$ | Device control |
| SOM | Start of message | DC$_4$(Stop) | Device control (stop) |
| EOA | End of address | ERR | Error |

Legend continued on following page

TABLE 1

| VENDOR | DESIGNATION | FREQUENCY | GERMANIUM OR SILICON | MILITARY? | NOISE REJECTION VOLTAGE | CONNECTOR TYPE | NUMBER OF CONNECTOR PINS | NUMBER OF DIFFERENT CIRCUITS AVAILABLE | LOGIC LEVELS "1" | LOGIC LEVELS "0" | POWER SUPPLY VOLTAGES | LOWEST PRICED FF | TEMP RANGE °C | DIMENSIONS (INCHES) | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| APPLIED DEVELOPMENT CORP. | 10-X0X | 100KC | G | NO | 1V | PRINTED (PINS ARE 54 EXTRA PER CARD | 31 - PRINTED | 88 | -7.5V ± 0.5V | 0V ± 0.5V | -24, -24, -7.5 | 14.25 | 0 TO 55 | 4 3 4 x 4 1 8 | MTBF FOR FF 27,600 HRS POWER SUPPLIES AVAILABLE |
| APPLIED DEVELOPMENT CORP. | 10-X3X | 1MC | G | NO | 1V | | 34 - PINS | 77 | -7.5V ± 0.5V | 0V ± 0.5V | -24, -24, -7.5 | 18.75 | 0 TO 55 | 4 3 4 x 4 1 8 | MTBF FOR FF 32,400 HRS |
| APPLIED DEVELOPMENT CORP. | 11-X3X | 1MC | S | NO | 3V | | | 77 | -7.5V ± 0.5V | 0V ± 0.5V | -24, -24, -8.2 | 18.75 | 0 TO 85 | 4 3 4 x 4 1 8 | MTBF FOR FF 32,900 HRS |
| CONTROL EQUIPMENT CORP. | 500 | 250KC | G | NO | 1.5V | PRINTED | 15 | 23 | -3V | -11V | -12, -12, -100 | 29.75 | -45 TO +65 | 3 1 16 x 3 3 8 | 5% RESISTORS, POWER SUPPLY AVAILABLE |
| ENGINEERED ELECTRONICS CO. (EECO) | G300 | 100KC | G | NO | 1V | PRINTED | 22 MAX | 9 + 7 AUX | -8V | 0V | -12, -6, +6 | 15.40 | | 4 1 2 x 5 | POWER SUPPLIES AVAILABLE, VARICON CONN. $2.00 EXTRA PER CARD |
| ENGINEERED ELECTRONICS CO. (EECO) | G200 | 1MC | G | NO | 2V | PRINTED | 22 MAX | 9 + 7 AUX | -8V | 0V | -12, -6, +6 | 25.35 | | 4 1/2 x 5 | POWER SUPPLIES AVAILABLE, VARICON CONN. $2.00 EXTRA PER CARD |
| NAV. COM. CO. (NAVCOR) | 400 | 300KC | G | NO | | PRINTED | 18 | 66 | -6.6 TO -7.3 | 0 TO -0.2 | -12, +12, -100V | 9.50 | 0 TO +55 | 5 x 6 | POWER SUPPLIES AVAILABLE, NEON INDICATORS ON FF |
| WYLE LABORATORIES | M SERIES | 200KC | G | NO | | PRINTED | 22 | 23 | -10 ± 2 | -.25 ± .25 | -12, +12 | 12.00 | | 4 1 2 x 5 | POWER SUPPLIES AVAILABLE |
| WYLE LABORATORIES | H SERIES | 1MC | G | NO | | PRINTED | 22 | 17 | -10 ± 2 | -.25 ± .25 | -12, +12 | 15.00 | | 4 1 2 x 5 | POWER SUPPLIES AVAILABLE |
| COMPUTER CONTROL | S PAC | 200KC | G | NO | 1.5V | PINS | 34 | 19 | -6 | 0 | +12, -6, -18 | 9.96 | -20 TO +55 | 4 1/2 22 x 7 | POWER SUPPLIES AVAILABLE, METAL FRAMES |
| COMPUTER CONTROL | S PAC | 1MC | G | NO | 1.5V | PINS | 34 | 24 | -6 | 0 | +12, -6, -18 | 13.80 | -20 TO +55 | 4 1/2 22 x 7 | POWER SUPPLIES AVAILABLE, METAL FRAMES |
| COMPUTER LOGIC CORP. | L MODS | 300KC | G | NO | | PINS | 35 | 16 | 0 ± .5 | -10 ± 2 | -12, +6 | 17.50 | 0 TO +55 | 4 3 8 x 3 3 4 | POWER SUPPLIES AVAILABLE |
| DELCO | CD | 175KC | G | NO | | PINS | 35 | 25 | 0 | -6 | -12, -6, +1.5 | 25.50 | -60 TO +71 | 4 1 2 x 7 | POWER SUPPLIES AVAILABLE |
| DIGITAL EQUIP. CORP. | 4000 | [illegible] | G | NO | | PINS | 22 | 74 | -3 TO -4 | 0 TO -0.1 | -15, -3, +10, -10 | 22.50 | | 4 1 2 x 7 | POWER SUPPLIES AVAILABLE, METAL FRAMES |
| INTERNAT'L RESIS. CORP. | G-3000 | [illegible] | [illegible] | NO | | PINS | 29 | 13 | -5 | -0.3 | -8, -2 | 11.50 | [illegible] TO +55 | | |
| INTERNAT'L RESIS. CORP. | G-4000 | [illegible] | G | NO | | PINS | 29 | 14 | -5 | -0.3 | -8, -2 | 16.31 | 0 TO +55 | | SILICON IS S-4000. POWER SUP.: +8, -2. TEMP -55 TO +65 |
| INTERNAT'L RESIS. CORP. | G-1000 | 1MC | G | NO | | PINS | 29 | 14 | -5 | -0.3 | -8, -2 | 16.31 | 0 TO +55 | | SILICON IS S-1000. POWER SUP.: +8, -2. TEMP -55 TO +65 |
| NAV. COM. CO. (NAVCOR) | MC | 1MC | G | NO | 2.5V | PINS | 20 | 25 | -6.2 ± .2 | 0 TO -.2 | -18, +18, -100 (INDICATORS | 17.66 | 0 TO +55 | 5 x 6 3 8 | |
| PACKARD BELL | GXXX-.2 | 200KC | G | NO | 2V | PINS | 35 | 33 | -9 TO -12 | -1 TO -1 | -12, +6 | 8.75 | 0 TO +55 | 3 3 4 x 4 1 4 | POWER SUPPLIES AVAILABLE |
| PACKARD BELL | GXXX-1 | 1MC | G | NO | 2V | PINS | 35 | 28 | -8 TO -12 | -.5 TO -.7V | -12, +6 | 16.25 | 0 TO +55 | 3 3 4 x 4 1 4 | POWER SUPPLIES AVAILABLE |
| RAYTHEON | | 1MC | G | NO | | PINS | 20 | 18 | 0 | -6 | +12, -6, -18 | 24.75 | -30 TO +65 | 2 1 2 x 5 | POWER SUPPLIES AVAILABLE |
| RESE ENG | 2010 | 200KC | G | NO | | PINS | 16 | 15 | -6 | 0 TO -.15 | -18, -6, +12 | 10.00 | | | |
| RESE ENG | 2013 | 1MC | G | NO | | PINS | 16 | 11 | -6 | -0.5 | -18, -6, +12 | 19.00 | | | |
| SCIENTIFIC DATA SYSTEMS | | 250KC | S | NO | 1.5 TO 3V | PINS | 47 | 13 | -8 | 0 | +25, -6, -25 | 25.00 | 0 TO +100 | 5 1 2 x 6 | POWER SUPPLIES AVAILABLE |
| SCIENTIFIC DATA SYSTEMS | | 1MC | S | NO | 1.5 TO 3V | PINS | 47 | 13 | -8 | 0 | +25, -6, -25 | 28.00 | 0 TO +100 | 5 1 2 x 6 | POWER SUPPLIES AVAILABLE |

TABLE 2

SHAFT ENCODERS (INCREMENTAL, MAGNETIC AND OPTICAL)

| | VENDOR | MODEL NUMBER | MAXIMUM RESOLUTION (COUNTS/TURN) | MAXIMUM READOUT SPEED (RPM) | DIAMETER (INCHES) | LENGTH (INCHES) | WEIGHT (OZ) | OPERATING TEMPERATURE RANGE (°C) | STARTING TORQUE (IN OZ) | LIFE EXPECTANCY (REV.) | PRICE | DELIVERY TIME (WEEKS) | AUX. ELECTRONICS REQ'D FOR OPERATION | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAGNETIC | DATA TECH | IC15-103-11P | 1000 | 3,000 | 1.5 | 3.06 | 6 | -10 TO +50 | 0.03 | $2 \times 10^8$ TO $2 \times 10^9$ | 495 | 2 TO 4. | OSC, AMP, PULSER, COUNTER | ELECTRONICS BUILT IN; BEARINGS CAN BE REPLACED; UP-DOWN COUNTER AVAILABLE |
| MAGNETIC | EMR, PRINCETON DIV | 505B | 256 | 10,000 | 2.25 | 1.25 | 8 | -55 TO +100 | .05 | $6 \times 10^9$ | 380 | 2 | OSC, AMP, PULSER, COUNTER | ELECTRONICS AND COUNTER NOT INCLUDED; 2 PICKUPS |
| MAGNETIC | LIBRASCOPE | 857-23 | 256 | 10,000 | 2.25 | 1.25 | 7 | | .04 | $4 \times 10^9$ | 300 | STOCK TO 4 | OSC, AMP, PULSER, COUNTER | ELECTRONICS AND COUNTER NOT INCLUDED; 4 PICKUPS |
| MAGNETIC | WHITTAKER CORP. | 15A | 1000 | 10,000 | 2.781 | | | 50°C | | | 250 | 6- | TELEPAK, TYPE 193E | MILITARY; STANDARD IS TYPE 15A |
| MAGNETIC | NORDEN | MADC/23/INC/256, FC | 256 | 5,000 | 2.25 | 1.00 | 10 | | | | 350 | 7 | OSC, AMP, PULSER, COUNTER | ELECTRONICS SUPPLIED BY USER |
| OPTICAL | DYNAMICS RESEARCH CORP. | OPTISYN 11 | 2048 | 3,000 | 1.062 | 1.300 | 3.1 | -35 TO +66 | .07 | $2 \times 10^8$ | 1350 | | SERIES 15-EL-4 LOGIC & COUNTER | LAMP SUPPLY = 5V, BUILT-IN ELECTRONICS ON SPECIAL ORDER |
| OPTICAL | WAYNE-GEORGE CORP | RI(XX)M | 4096 | 3,000 | 1.437 | 1 5/16 | 3 | -20 TO +63 | .15 | BEARING LIFE | 390 | 9 TO 12 | LOGIC & COUNTER | LOGIC AVAILABLE |
| OPTICAL | WANG LABORATORIES | 44-100 | 400 | 10,000 | 2.0 | 1.5 | 6 | | .1 | $3 \times 10^8$ | 250 | 4 TO 6 | LOGIC & COUNTER, MOD 2028, | LIFE OF LIGHT = 30K HOURS, UP-DOWN COUNTER AVAILABLE |
| OPTICAL | DYNAMICS RESEARCH | OPTISYN 23-100 | 400 | 3,000 | 2.3 | | | | | | 590 | | LOGIC 15-EL-44 & COUNTER | MOD 27-100 COSTS $485, BUT IS LESS RUGGED |

TABLE 3

| VENDOR | MODEL NUMBER | MAX TAPE READER SPEED (CHAR/SEC) | MAX TYPING SPEED WORDS/MIN) | WEIGHT (POUNDS) | DIMENSIONS (INCHES) | RFI ELIMINATION TECHNIQUES | MILITARY? | SHOCK & VIBRATION | OPERATING TEMPERATURE RANGE | LIFE EXPECTANCY (HOURS) | MODULAR CONSTRUCTION? | PRICE | DELIVERY TIME MONTHS) | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TELETYPE | 35AW | 10 | 100 | 145 | 36.5 x 40 x 24 | RC ACROSS COIL | | | | 100K + | YES | 3532 | 5 | NO LOCAL REPAIR ORGANIZATION |
| DURA | MACH 10 | 15 | 175 | 60 | 28 x 16 x 8 | SILICON DIODES ACROSS COILS | | | | | YES | 4200 | 5 | RELAY VOLTAGE, 35V, POWER, 200W, QUIET OPERATION |
| MITE | AN/TGC-15 | 17 | 200 | 80 | 15 x 15 x 19 | | YES | | | | | 8000 | 19 | CURRENTLY UNDER DEVELOPMENT |
| KLEINSCHMIDT | 321 | 60 | 400 | | 22 x 26 x 9 | | | | -32F TO +132F | | YES | 8000 | 15 | UNDER DEVELOPMENT; POWER, 250W |
| FRIDEN | F10 | 10 | 100 | | 15 x 21 x 9 | RC ACROSS COIL | | | | | NO | 3700 | 4 | RELAY VOLTAGE, 90V, UNREG; LOUD OPERATION |
| ROYAL MCBEE | | 10 | 100 | 80 | | LOW DC VOLTAGES, USES FF | | | | | | 4000 | 6 | ASA BEING DEVELOPED, TR, TP, & TYPEWRITER ARE 3 SEPARATE UNITS |

**TABLE 4**

# SECTION 6

# DETAILED DESCRIPTION OF THE PRINTING FUNCTION

## 6.1 STATEMENT OF THE PROBLEM

The basic problem which has to be solved in the output of the final chip printer is the obtaining of digital information from a paper tape source and presenting this information to the chip in alphabetical and machine code form. This translation of digital information to alphabetic, human readable form is in an area where presently considerable amount of work is being done by many companies to solve this particular problem. Due to the size configuration of our output date block, the size character being used, and the problem of exposing on a ASA of 0.1 film excludes many of the standard approaches. The combination of the small letter size and high speed requirements required a detailed and exhaustive study into every perfected method of performing this function. Whereas, some developed systems were good in their own specially designed applications they could not be used in the chip printer unit. After several months of investigation, three methods were seriously considered as being applicable to our problem. The three methods that have the best possibilities of doing this particular task are:

1. A composite solution of rotating font for character generation working with a second method of producing the machine code.

2. Silicon light pulser data block array

3. CRT tube type presentation.

## 6.2 DIFFERENT METHODS STUDIED

It is conservatively estimated that since the beginning of proposal writing to the present day, twenty systems have been investigated. Of these twenty systems, many were ruled out immediately for the following reasons:

- Inability to get enough light to expose a 1/10th ASA film.
- The inability to produce letters of the proper spacing and size.
- The inability to produce letters at the proper speed to allow us a reasonable cycle time.
- The exhorbitant cost for producing the unit.
- The large space that would be required in order to perform this function.

In the last category such items as cathode ray tubes and flying spot scanners do not lend themselves to a small easily packaged unit. Both projected and reflected light using a counter device through an optic system onto the chip were disgarded because of failure to produce enough light. Methods were investigated by which a font was positioned by the row and by the letter with a reflected mirror, but this method was impractical because the accuracy required was beyond the state-of-the-art in the stepper motor industry. A method of placing the entire alphabetic and machine code on one rotating font was investigated and was considered impractical in the case of placing two machine codes with each character printed on the output data block. This approach also would require a new font wheel for any change in the input code.

## 6.3 RECOMMENDED METHOD AND REASONS FOR SELECTION

Of all of the systems studied, two systems stand out as the most practical for the solution of our problem.

- Method 1

  Rotating font with individual hammers for machine code.

- Method 2

  Silicon light pulser data block.

Of the two methods, it is considered the solution that is most reasonable in price and the quickest to develop would be the first method stated. The second method would provide a more universal type generator by which at a later date many changes could be made with very little hardware change. This price estimate has been estimated using the first method. The second method is presented in appendix A of this report to allow the reader, if his conditions are such, that a more universal reader is required that he may request the second unit to be incorporated into the chip printer package. All designs and preliminary layouts and cost estimates have been made in this report using the method of the rotating font with the machine code hammers.

## 6.4 DETAILED OPERATIONAL DESCRIPTION

The Figures 4 and 9 will be needed to help describe detailed operation of the printed function. As was discussed in Section 5.3, the input information is switched to the character generation station at the proper time of the operation cycle. As can be seen in Figure 4, the input information is converted into a two digit number by means of the matrix converter. This number presented to the one side of the comparator. The rotating font wheel with each letter correspondingly noted by an engraving on the tone wheel is converted into a count by the counter and presented to the second input of the comparator. This count is recycled by having a larger engraving preceding all of the letters. Every time the magnetic pick-up head detects this large engraving, it will rezero the counter. When the font count and the converted matrix number ~~were~~ are equal, a signal is given that will activate the letter hammer. This equal signal ~~would~~ will also reset the comparator.

The machine code would immediately be presented to the machine code keys, which would be set to the same American standard code setting as the input presented. The only change to the input code is that the timing pulse will be added to the 5th code position and all the subsequent bits would be shifted down by one. The last bit presented would be the even parity bit. After the machine codes have been set a signal will be given through a time delay circuit that would activate the machine code hammer. As shown in Figure 9, the machine code will operate independently to the character code. Both the machine code and the character code will start at the same time but due to the random operation of locating the proper character on the rotating wheel, the letter cycle may have to take up to 55 milliseconds before its located and printed. The machine code can have hammer action after 20 milliseconds as shown in Figure 9. Therefore, the total print of the machine and character printing will occur at the end of 60 milliseconds. The balance of the time will be used to transport the Cronapress ribbon. While the Cronapress is being transported, all the machine code keys are recycled and the printer is ready for the second step. As can be seen on Figure 4, the next step would be a position where only the machine code is printed. As shown by the symbols, the second operation will be of the machine code only. This will require the storage of the second letter, while the machine code is printed out. The third operation will then be of the third number in the machine code, in this case a 7, while the 2, or the second number is printed in alphabetical characters. As can be seen from the chart as we go on with the operation cycle, we require more and more storage of the character numbers and for controls for presenting the proper number at the proper time. Carrying out 11 operations, it is seen that a progression is worked out. This shows that for every two characters, an additional character in storage is required such that if 56 alphanumberic characters are displayed, a 28 character storage would be needed. The storage control circuit will provide the controls necessary for the introduction of the proper character to the comparator at the proper time.

## 6.5 BREADBOARD RESULTS

In order to prove feasibility of obtaining a clear, sharp character image upon the Cronapress tape while using a font turning at 600 rpm as a character source, a breadboard was built. This breadboard had a constant speed motor, turning at 600 rpm, and on the shaft of this motor was placed a 80 tooth gear. A No. 1 Ledex solenoid was used to energize a hammer which was sent into free flight, by a pulse from a magnetic pick-up, which at the proper moment struck an appropriate tooth consistantly on the gear. The Cronapress tape was placed in between the solenoid hammer and rotating gear. The Cronapress tape had a imprint of the tooth face. The Cronapress tape has been subjected to all types of handling conditions such as pressing your finger as hard as possible, and does not easily deteriorate or smudge.

The results of this breadboard work has convinced us that a free flight hammer technique is completely feasible, both for the character generation and as well as the machine generation codes.

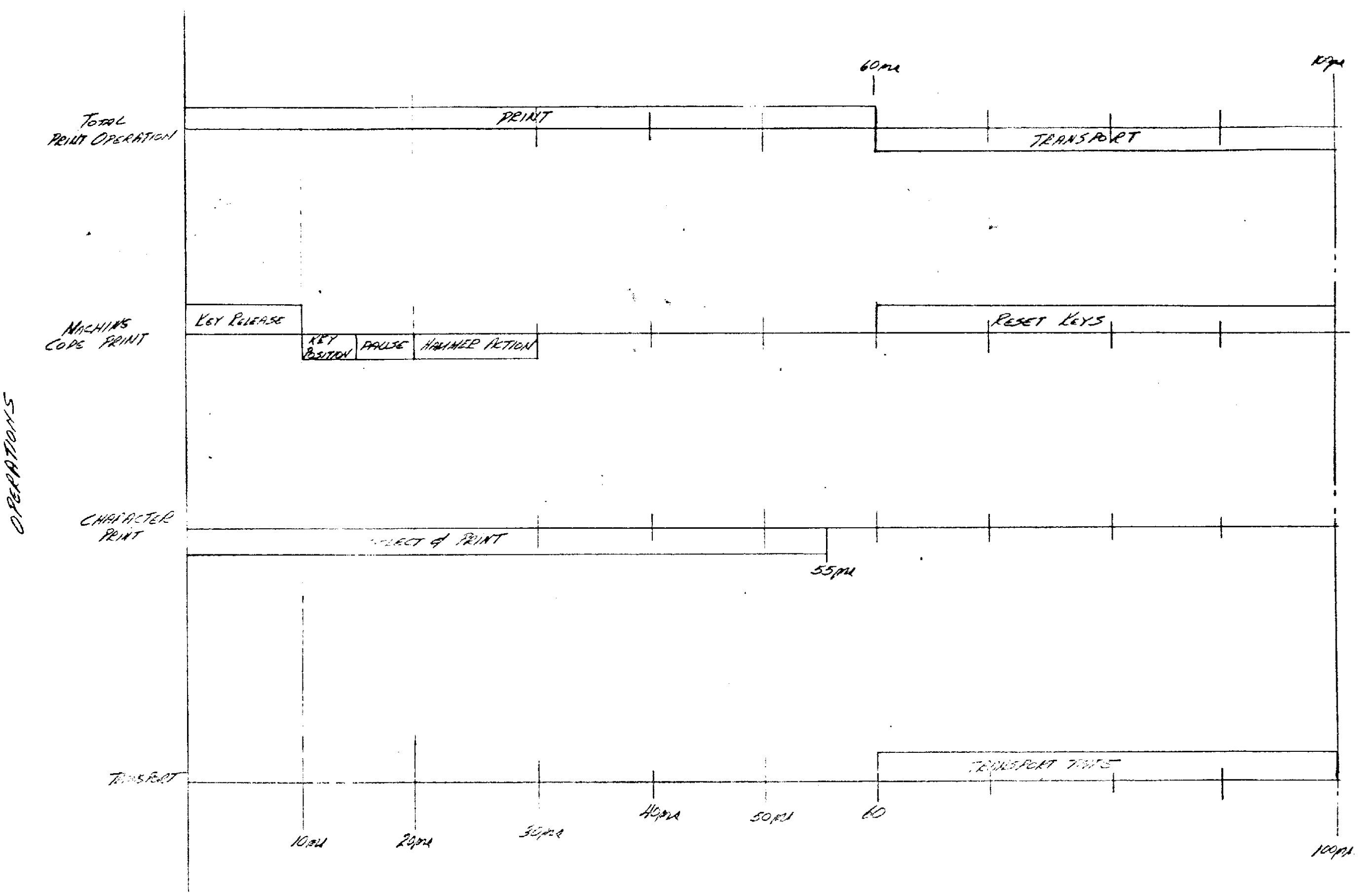



FIGURE 9. DATA RECORDING TIMING CHART

[redacted]



25X1

# SECTION 7

## DETAILED DESCRIPTION OF THE SERVO CONTROL

### 7.1 STATEMENT OF THE PROBLEM

The objective of the servo is to position the film to a point corresponding to a set of numbers fed into the system from a punched paper tape. There are individual servo drives and reference encoders for X, Y, and azimuth. These drives and encoders are switched to allow use of the same comparator and storage register in the various servo modes. This arrangement results in a saving of approximately 90 circuit cards, which would be required if the circuits were repeated for each servo.

The servos are positioned one at a time, and the input tape is stopped after reading of the number for a given servo. When the servo operation is completed the circuits are cleared and the next number is reading from the tape, allowing servo operation to begin again, in the next axis.

The servo should be able to reach its required position with a reasonably high speed and a minimum of overshoots, and it should be stable. The desired accuracy of positioning is 0.008 inch, and the servo should be capable of positioning in either the positive or negative direction from the zero reference or from a previously positioned point.

### 7.2 DIFFERENT METHODS STUDIED

Various methods for accomplishing the above tasks were considered. One possibility was to feed a stepper motor with a number of pulses corresponding to the input number. An investigation of stepper motors revealed that it would not be possible to meet the torque requirements for slewing with a stepper motor. In addition, the positioning would not be precise due to equivalent backlash in the motor and variation in the step size. This is an open loop system, and there would be no way to correct this error. Since the motor can move only in steps, the resolution of the system is limited to the size of the step.

For these reasons, it was decided that a stepper motor would not be suitable for this application. A motor which does meet the requirements much more suitably is a direct-drive DC torque motor. This kind of motor can easily supply the amount of torque required, and it is capable of infinite resolution.

A servo is required for accurate positioning of the film, particularly when a stepping motor is not used. Therefore, a feedback element is required, to supply a signal corresponding to the position of the film. There are many possible forms of the feedback element, and the choice of the form depends on the context of the particular system, with the considerations including accuracy and resolution required, size and shape of the element, interaction with other parts of the system, and type of servo used.

The positioning information comes into the system in the form of digital numbers on punched paper tape. There are two basic methods for positioning from this input information. In one method, the digital information is stored and then fed to a digital-to-analog converter, giving out a voltage corresponding to the stored number. This voltage is compared with a voltage, corresponding to current film position, from the feedback element, which could be a device such as a potentiometer or a resolver. The difference between these two voltages would be applied to a linear amplifier that drives the torque motor, and the direction of drive would be that which reduces the difference.

For a number of reasons, it was decided that this system should not be used. The reasons are enumerated below.

1. The motor required for the system has a peak torque of 1.8 foot pounds and a friction torque of 0.035 foot pound. Two motors are required in the system, doubling the net friction torque. If a positioning resolution of 0.008 inch is desired, then this error must provide at least enough motor current to overcome the friction torque. If there is no other friction in the system, the motor would saturate at a distance of 0.184 inch from the match point. With a total travel of ±25 inches required, the linear region would be a very small percentage of the total travel. A servo such as this would be extremely difficult to stabilize, and gain could not be reduced, since this would mean a corresponding reduction in resolution.

2. A resolution of 0.008 inch in ±25 inches requires a 13-bit D-A converter, which is very expensive and which adds error to the system due to inaccuracies in the conversion.

3. A very linear, high resolution feedback element would be needed.

4. Error introduced in taking the difference of two analog quantities would add to the system error.

5. Noise would reduce the resolution and add to the system error.

In the second method, the servo control is operated in a completely digital mode. The feedback element provides a digital number corresponding to the position of the film. This number is compared with the stored reference number in a digital comparator. If there is a difference between the two numbers, a signal is applied to the drive motors to run the film in the direction which will reduce this difference. The output of the comparator is one of three possible signals; high, low or equal. There is no information from those three outputs as to how large the difference is. Therefore, the voltage to the motor is the same for a difference of 1 as for a difference of 1000 or any other number. In this system, the magnitude of the speed of the motor has no basic effect on the maximum resolution. However, in order to stabilize the system, the speed must be adjusted to a point below that which causes oscillations. The speed at which the system will oscillate varies with different system parameters, particularly with resolution. With higher resolution, oscillations will occur with a lower value of speed. The friction in the system determines the lowest speed which can be used, since a certain amount of torque is required to overcome the static friction, and the running friction is less than the static friction. Thus the speed cannot be brought below a certain point without having the film stop at peaks of friction. Thus the resolution with a stable system is essentially limited by the static friction for this method as well as for the first method. However, the maximum resolution with stability in this method is greater than in the first method since the saturation effect described above causes a change from full speed to zero in 0.18 inch, whereas the null can be approached at a constant low speed in the digital method.

If the speed is kept at the low value throughout the entire travel, it would take a long time to reach the match point. For example, if the travel required is 25 inches, and the speed required for stability is 0.1 inch per second, it would take 250 seconds, or four minutes and 10 seconds to reach the null. In order to speed this up, a modification can be added to the system, such that when the film is far from the matchpoint is reached, the speed is reduced to the value required for stability. The method for determining the point at which the speed is changed depends to some extent on the type of servo control used.

The key section of the servo control in the digital mode is the digital comparator. This comparator can be used in one of two basic forms, either serial or parallel. The serial form was chosen for breadboarding and testing, since it required less circuitry than the parallel form, and it appeared to be capable of performing all required servo operations correctly.

## 7.3 BREADBOARD RESULTS

Packard Bell circuit cards were selected for building the servo control since they are a good combination of high quality and small size, proven reliability and low cost. A circuit diagram of the breadboard servo control is shown in Figure 10. The rectangles represent Packard Bell circuit cards, and the numbers outside the rectangles are the pin numbers. The diagram shows both the readin and the storage shift register for the information from paper tape, and the comparator with associater gating. The number on the paper tape represents the point to which the film is to be driven, and it is a four digit number in bcd plus sign. The output of the tape reader is fed to one-shot multi circuits to eliminate contact bounce, and the outputs of the multis are gated to the proper sections of the shift register, four bits at a time. This is accomplished by applying the outputs of the multis to an OR gate and feeding its output to a binary counter, which is card no. 5. Each count in this counter enables different sections of the shift register, storing the information in its proper place. The

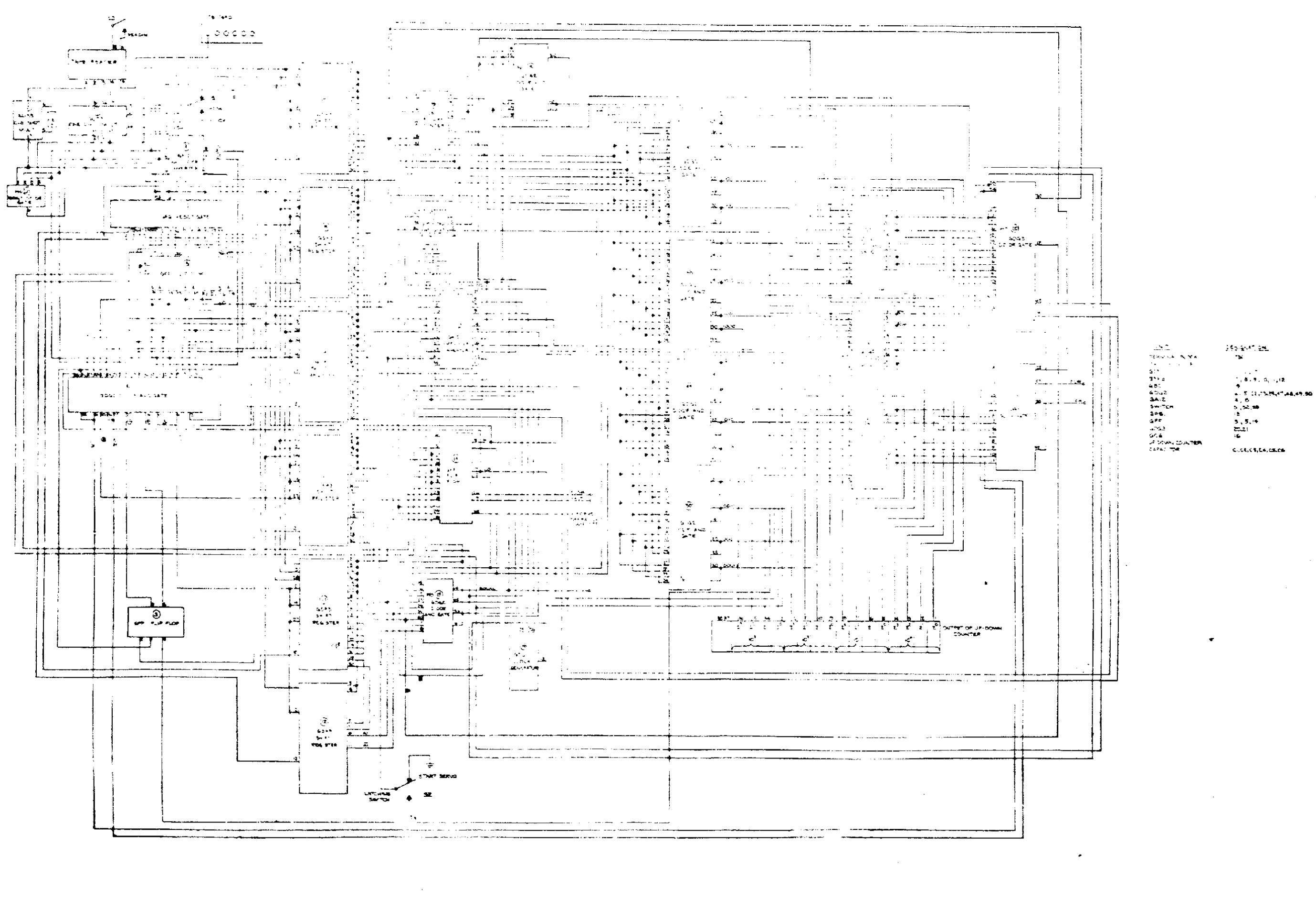


FIGURE 10   BREADBOARD DIGITAL SERVO CONTROL WIRING DIAGRAM

operation of the comparator will be described with reference to the block diagram, Figure 11.

The most significant bit of the shift register is taken as one of the inputs to a one-bit digital comparator. The other input to the comparator is taken through gating from the counter output. The comparison is made one bit at a time, and the two numbers must be kept in synchronism during the operation. A binary counter is used to store the position of the shift register and to select the bit from the counter to be used in the comparison. This selection is made by feeding the output of the counter to a converter, which gives an output on one of 17 lines. These lines are gated with the output lines of the counter, enabling only one of counter outputs. The outputs of the 17 gates are fed to an OR gate, and the output of the OR gate is determined by the counter output which is enabled. 17 lines are used to give four bcd digits plus sign. On the actual breadboard only 16 lines were used, leaving out the sign, but the principle of operation is no different.

At the start of the operation, the most significant bit of the input number and the most significant bit from the counter are applied to the comparator. Nothing further will happen until the start-servo switch is pressed. When this is done, the clock generator is gated into the comparator. The comparator output is at Equal at the start, and it will remain this way if A and B are equal. If A is 1 and B is 0, the clock will switch the output of the comparator to High, or, with the opposite input, to Low. If A and B are not equal, there will be an output signal to drive the film in the direction that will bring them to equality. When they are equal, and AND gate will be enabled, allowing the clock to pulse a one-shot multi. The output of this one-shot multi will pulse a second one-shot multi at the trailing edge of the first, and the output of the second multi is gated with the Equal output. The output of this gate feeds a count into the binary counter,

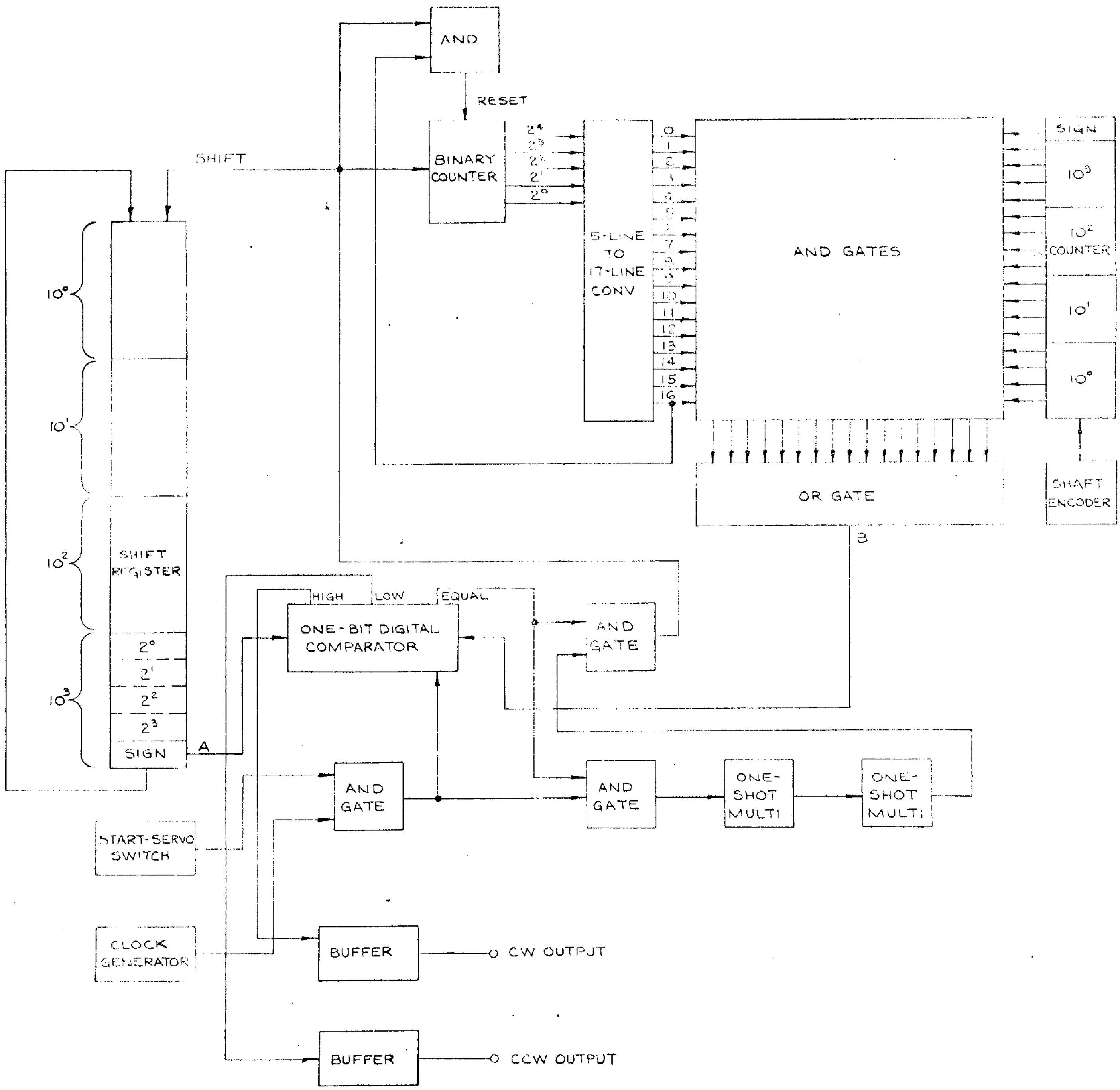



FIGURE 11. SERVO CONTROL BLOCK DIAGRAM

25X1

and at the same time shifts the shift register one place. The comparison is then made with the next bit, and the process continues with each bit until the entire number in the counter is equal to the reference number. In the first setup of the breadboard, the number in the shift register was run through one time only, bringing the film to the correct position, and then effectively opening the loop. This was found to be unsatisfactory because a final overshoot or any disturbance in the system at the end of the run would bring the film off the desired position, with the system having no capability to correct the position. To eliminate this problem, the output of the shift register is connected back to the input, so that the number is circulated around instead of being lost, and the comparison can be repeated to correct any tendency to move off the correct position. When all the corresponding bits of the two numbers are equal, the total comparison will run through quickly, at approximately the clock rate. The reason for this is the following. When the comparator output is Equal, the first one-shot multi is pulsed by the clock. It is then turned on, and it stays on for a certain period of time, as determined by the values of its components. While it is on, it will be hit by more clock pulses, but these will have no effect. When it finally goes off, it pulses the second one-shot, which will cause a shift at its trailing edge. In the meantime, the first one-shot is again turned on by the clock, and it will continue to be turned on every time it goes off, at the next clock pulse, as long as the output of the comparator is Equal. When the shift occurs, if the output of the comparator goes to either high of low, the first one-shot will no longer be hit by the clock. However, at this time the one-shot will most likely be on. If the first one-shot is on after the shift, it will turn the second one-shot on once more. At its trailing edge, it will cause another shift if the output of the comparator is Equal, or it will do nothing and both one-shot multis will be off if the output of the comparator is either high or low. The period of the second one-shot can be made short, in the order of the period of the clock, while the period of the first one shot is longer. This will allow cycling at approximately the clock rate when both numbers are equal.




Sanitized Copy Approved for Release 2011/05/03 : CIA-RDP78B04747A000800010009-4

25X1

The one-shot multis serve two main purposes. When the servo is started the comparator is in the Equal state, and without the delay provided by the multis there would be an immediate shift to the next bit. In addition, the multis provide a delay between shifts to allow time for the circuits to settle, preventing the possibility of improper shifts.

The circuit was tested in the servo, and worked as predicted, giving good servo operation for most input reference numbers. However, it was found that certain numbers cause undesirable servo operation. These numbers are 1000, 2000, 3000, etc. It was observed that with 1000 as the reference number, the film would move until the shaft encoder reached that number and would then sometimes stop and sometimes go backward to some point at which it would reverse and come back to 1000. When it came back it would again sometimes stop and sometimes reverse and go backwards. The reason for this was deduced by thought, and it was found that there are two independent reasons. The first one is the finite settling time of the counter circuits. When the match is approached, the counter goes from 0999 to 1000. When the counter number is below 1000, the shift register is stopped at the fourth bit of the most significant digit, which is 1 in the reference and zero in the counter. When the counter changes from 0999 to 1000, the bit at the comparator becomes 1, causing a shift to the next bit. This should be zero in both the reference and the counter. However, this bit was just previously a 1 in the counter, and it requires some time to change to zero. If it has not yet changed to zero when the shift has occurred, the comparator will reverse its signal at this point, running the film backwards. The servo is still at high speed in this case, since the change in speed occurs when the shift register transfers from the last bit of the second digit to the first bit of the third digit. The film in this case runs back until the counter reads 0000, and it then reverses to go back to 1000. This problem could be eliminated by increasing the speed of circuit operation in the counter (i.e., faster flip flops, etc.), and/or increasing the time delay in the multis.

The second reason, however, seems to be a more basic problem. When both numbers are at 1000, all bits are equal, and the shift register is freely running through the number, and it is a matter of probability which

[redacted]

 25X1

bit will be at the comparator at any given time. If the film is moved to make the number in the counter 0999, it will go back to 1000 if the comparator happens to be looking at a bit in the most significant digit at that time. If the comparator is looking at any of the other three digits, the film will go away from 1000, to a certain point, then reverse and head back to 1000. Depending on which bit is in the comparator at the change, the points which will be reached are 0000, 0800, 0900, 0980, 0990, or 0998. Because of the basic nature of this problem even though it occurs only at special numbers, it was decided that for optimum results, it is necessary to use a parallel comparator, rather than a serial comparator. A parallel comparator looks at the entire number at once, and cannot have the kind of problems described above. The parallel comparator should give slightly better servo action than the serial comparator, since it has less inherent time delay, but since this time delay is very short compared to the servo response, it probably will not make much difference.

## 7.4 RECOMMENDED METHOD AND REASON FOR SELECTION

The recommended method is a digital servo with a parallel comparator which compares the entire digital reference number with a digital number derived from a shaft encoder used as a feedback element. The reasons are higher resolution, higher accuracy, and simplicity of circuitry compared to analog methods. This same type of servo control can be used for all axes, X, Y, and Azimuth. The method to be used for reducing the speed is to use a subtractor to signal a speed reduction when the difference is less than a selected magnitude, such as a difference of 50 or less. This method gives a constant run length at low speed, regardless of the reference number.

25X1



# SECTION 8

# DETAILED DESCRIPTION OF THE SERVO DRIVE FUNCTION

## 8.1 STATEMENT OF THE PROBLEM

The drive system must be capable of driving the film smoothly to the desired position, in either direction, must provide and maintain film tension, and must operate consistently over the range from an empty spool to a full spool. In addition, the motors should be capable of meeting the requirements of slewing in the manual mode.

## 8.2 DIFFERENT METHODS STUDIED

The different methods studied included the use of stepper motors, direct drive dc torque motors, torque motors or servo motors with gearing, and a capstan drive system with two additional motors at the reels for maintaining film tension.

The stepper motor was rejected for the reasons given in section 7.2. The other systems were considered, and it was decided to use the direct drive dc torque motor. This was selected because of the high resolution, high torque-to-inertia ratio, high coupling stiffness, and low-speed capability inherent in a direct drive torque motor. A motor with a gear drive has many disadvantages, including inaccuracy due to backlash, reduced torque-to-inertia ratio at the load shaft by the factor of the gear ratio, and space problems involved in mounting the gears. In a digital servo, the backlash in gearing adds to the problem of stabilization.

 25X1

A capstan drive was not selected because it offers no advantages over the drive at the reels, since the motors are still required at the reels to provide film tension. In addition, there is the possibility of slippage at the capstan, and it adds some additional friction to the system.

## 8.3 RECOMMENDED METHOD

The recommended method is to use two direct drive torque motors, one at each film reel, to provide both film tension and drive. The reasons for this choice are given in section 8.2. An additional advantage of this system is that while one motor is driving, the other motor is being driven and acts as a brake due to its back EMF. This helps to maintain film tension, and also acts as viscous damping, improving servo stability. In addition, tachometer feedback should be used, separately for each motor, to improve servo stability.

## 8.4 BREADBOARD RESULTS

The circuit used in the breadboard is shown in Figure 12. The cw and ccw outputs from the servo control are taken as the inputs to the servo film drive, and are shown at the left of the diagram. One of these lines will be at -12 volts and the other line will be at zero volts while the servo is driving, and both lines will be at zero volts when the matchpoint is reached.

These signals are applied through an attenuator to the preamplifier. This preamplifier feeds the power amplifier, which supplies power to the drive motors. In series with the servo control signal, after the attenuator, is tachometer feedback. There is a Fast-Slow relay, energized by a signal from the servo control, which changes the speed of the drive motors during the servo operation. The contacts of this relay are shown in the diagram, shown in the Fast position, and designated by the word "fast". In the Fast position, the attenuation is reduced, increasing the voltage to the amplifier, and thus increasing the speed of the motor.

25X1

During the testing of this system, it was found that the two motors were not actually the same, in that they did not provide the same amount of output torque for the same amount of input current. This difference was significant, and it was observed that the film ran much slower in one direction than the other, beginning at the same starting point and using the same input current. This problem was solved by using individual tachometers, with independent output contrls for fast and slow speed, for each direction of film drive. Relays K1 and K2 switch in the correct tachometers and drive motors, depending on the direction and magnitude of the voltage output from the power amplifier. The tachometers are set so as to reduce the voltage to the faster motor as its speed tends to increase, thereby reducing the speed; the tachometer used with the slower motor is set to give a smaller feedback voltage, thus reducing the speed of this motor to a smaller extent than the other. By adjustment of the tachometer pots, the speed can be made approximately equal in both directions.

In low speed, a different pot is used for each tachometer, allowing independent adjustment to give the best condition of stability.

This system can be improved by using separate relays to switch the tachometers in and out, and to switch the drive motors in and out. This would allow better advantage to be taken of the viscous drag of the driven motor at slow speed while approaching the null. With the system shown in the diagram, with one relay used to switch a tachometer and a motor together, it is not possible to have both motors connected to the power amplifier, and only one tachometer in the system. Since the tachometer gives a greater amount of stabilization than the driven motor would give, it is connected in at the approach to the matchpoint, rather than connecting in the driven motor and opening the circuits to the tachometers.

It was found that with a resolution of 0.012 inch per count, the system was fairly easy to stabilize over most of the length of the film, with no readjustments once the proper settings were made. These settings include tachometer output voltages for fast and slow speed, fast and slow speed control, and bias voltages. Near the end of the roll of film, it was necessary to make a slight adjustment in the voltage input to the drive motors to achieve stability. This could be corrected by using the arms which ride on the roll of film, providing bias adjustment, to also provide some speed adjustment.

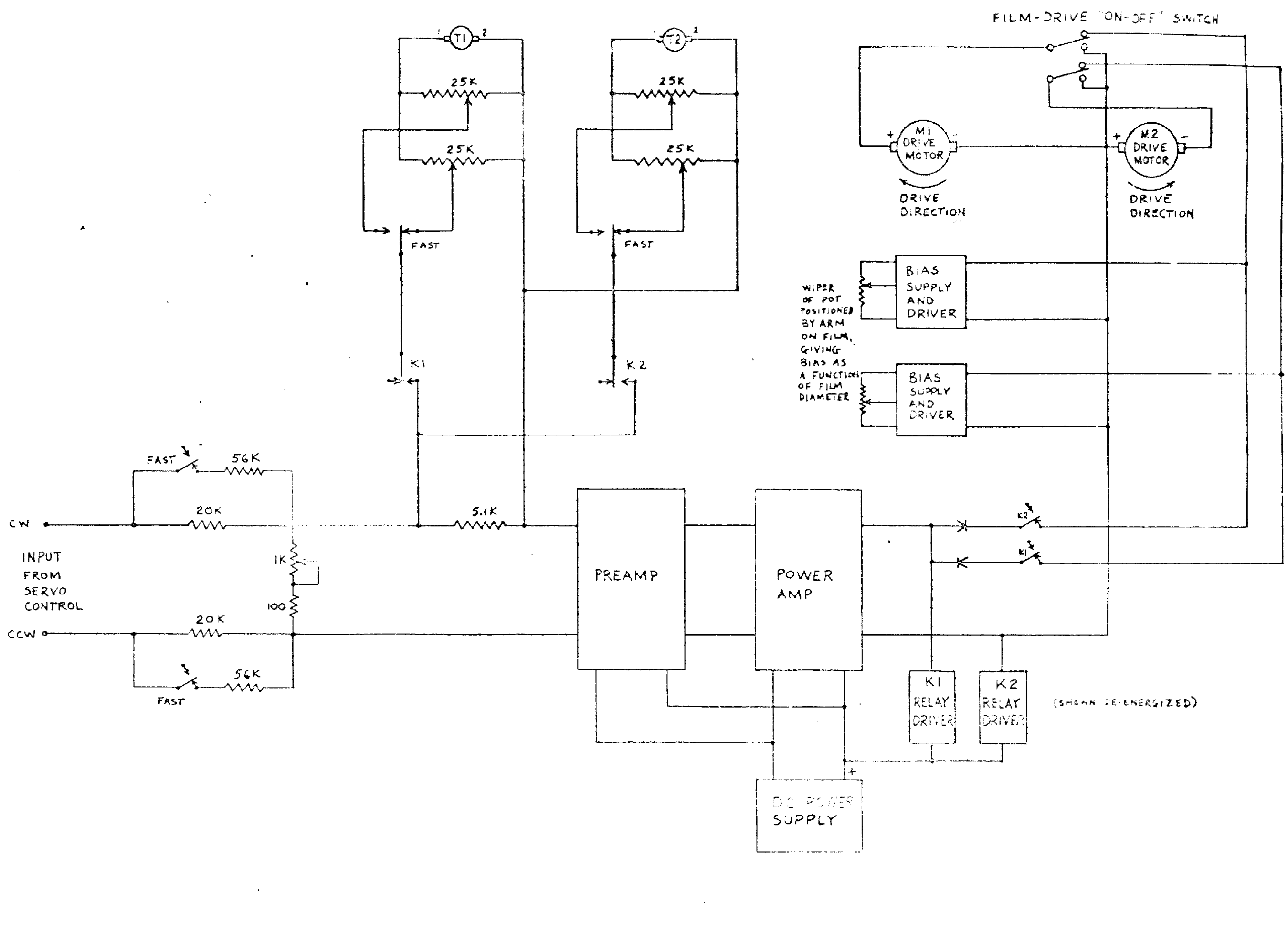



FIGURE 12. SERVO FILM DRIVE SYSTEM BLOCK DIAGRAM

Final Report Of Phase I 25X1
Program 105
30 January 1965

# SECTION 9

## DETAILED DESCRIPTION OF OUTPUT CHIP FUNCTION

### 9.1 STATEMENT OF THE PROBLEM - (Magazine Output Handling)

This section covers the design problems pertinent to the Magazine and its associated electromechanical subassemblies.

The Detailed Operational Description of the Magazine interlock and sequencing is covered in Section 9.2.

The prime requirements for the controls pertinent to the magazine sequencing are summarized below as follows:

a. Selection of Numbers of Chips

b. "Initiate" Controls

c. Timing and Sequencing of Events

d. Automatic Recycle

e. Automatic Ejection of Processed Chips

f. Zero Reset of Chip Counter

g. Automatic Shutdown of System

The concept described in Section 9.2 for preselection of chips is a manual operation. While it is entirely feasible to accomplish preselection by programming, together with all "data record" information in the present phase of development, it is advantageous to discuss the magazine circuitry in its entirety as a single component, not dependent upon compatibility with the logic controls. Since the principle described in this report is simple and workable, with all controls integral, it is probable that this concept may afford merit upon evaluation over the programming concept. The one significant advantage of this manual method is the achievement of reliability, since the magazine will not become inoperable in the event of any malfunction within the logic system.

— Initiate Controls

In the method described, the Initiate Control is a single push button switch, which starts the operation of the system. The duration of operation continues until the last chip of the number selected has been fully processed.

— Timing and Sequencing

The timing for the events which take place is accomplished by means of electronic timing circuits. The sequencing is accomplished throughout by means of relays, most of which are latching type units.

It is realized the timing for all events may be accomplished by means of a suitable clock. This method, however, is more accurate time wise and does not eliminate the interlock complexity of the switching, since the current required to perform the switching must be carried by adequate current carrying devices, either relays or solid state switches. A significant advantage of the electronic timing over that of a clock is that the events must take place sequentially. In the event that one mechanical drive should retard (due to mechanical friction which may develop) the next event cannot take place before the completion of the former event.

Solid state electronic will be used where required but the major portion of this control circuit will consist of the latching type relay switches.

- Automatic Recycling and Chip Rejection

The Automatic Recycling and Chip Rejection are controlled by micro-switches precisely located on the moving mechanical members. Such devices have often been employed for such duties, as they are reliable and dependable. These switches determine the sequencing and precise timing of the events.

- Zero Reset of Chip Counter

The Chip Counter, which shows the number of chips that have been removed from the cassette for processing automatically returns to zero subsequent to removal of the last chip. This is controlled by an integral switch within the counter. With removal of each chip, the counter increases by one digit. As the counter attains the final number selected, the switch produces a signal which resets the counter to zero.

For breadboard work an analog method was used to perform this function but for the final design it is planned to perform this function by digital means.

Automatic Shutdown of System

In the description, (Section 9.3), the Automatic Shutdown of the system is shown to be accomplished by four (4PPT) relays. These relays are operated by independent switches actuated by buttons at station one and station four.

Because of the number of circuits that must be controlled by these relay switches, it is believed to be the simplest and most reliable means for achieving the required controls.

While the control system presented is not considered to be a final design concept, it does present a complete and practicable means for achieving the magazine requirements.

As to reliability, the final design will be based upon the most stringent test evaluations in order to enhance the operation with complete trouble-free performance.

## 9.2 DETAILED OPERATIONAL DESCRIPTION

In this section the sequence of events relating to the magazine and its associated electro-mechanical assemblies is covered.

For this discussion the method for selection of the number of chips for print reproduction is shown to be manual only. The final design will, of course, provide for programming this information simultaneous with the data recording.

With reference to Figure 13 Functional Schematic Diagram, the complete sequence of events from the selection of chips to automatic shutdown of the system is described.

Before considering the events taking place during an operational run, it is important to point out the purpose of series capacitors on many of the latching relays. All latching relay windings are designed for 12 volts, dc. Those relays with series capacitors are actuated by limit switches or such which remain closed to 28 volt power. The capacitors are of such value that the differentiated pulse is more than adequate to latch the relay, since a 28 volt pulse is applied to a 12 volt winding. By use of the differentiated pulse, the switch applying the power may remain closed and another differentiated pulse applied to the adjacent winding will latch the relay to the opposite position. In those areas where the relays are latched by momentary switch closures, series dropping resistors are employed for economy purposes.

The operational sequence of events is described thus:

a. Set in the desired number of chips for print reproduction on the two selector switch dials. Number 47 shown in Figure 13 diagram for illustration. These selector dials will determine the number of chips to be removed from the cassette to the platen. If both dials are set to zero, the system is inoperative by means of cam actuated switches which inhibit the initiating signal as shown.

b. With the selection of chips determined, press the manual initiate switch S1, to start operation of the system. This switch is inoperative after

Page Denied

the first pressing, since all subsequent events and repeat subcycles will automatically take place until the last chip (of the number selected) has been processed.

One subcycle consists of the events which take place while the chip is in Station 1. In the subsequent subcycle the chip is rotated to Station 2.

One cycle consists of complete processing of one chip at which time the chip has been rotated three quadrants of the turret to Station 4. It, therefore, follows that four subcycles are required to complete one operational cycle. The pressing of the initiated switch and S1 applies 28 volts to the initiating circuit as shown. This circuit closes relay K5 for a predetermined time interval irregardless of the time S1 is held down by the operator.

c. As K5 closes, two functions are performed. Contact "a" closes a ground circuit (momentarily) to the common contact of four micro switch located at Station 1 of the turret. One of these switches is in the down position as shown. By completing the ground circuit, the relay (K1 - K4) in the circuit of the micro switch which is "down" latches to the opposit position. As shown K1 through K4 are provided with independent switch sections. Section "a" provides for automatic start of the following subcycles. Section "b" provides for removal of vacuum at completion of a run and also provides a signal for automatic shutdown of the system. Section "c" operates the vacuum solenoids and section "d" shunts the pressure switches at proper time intervals during the cycle. These relays are discussed in later paragraphs.

The second function of K5 relay is application of dc power to the chip mechanism solenoid via switch contact "b".

d. As K5 contact "b" energized the chip solenoid, its plunger liits from a one revolution wheel and simultaneously shifts the position of micro switch S2 to lift. As this occurs the return circuit to one energizing coil of K6 is completed latching its contacts in direction of arrow (left). S2 also completes the circuit to the shutter which opens to provide for automatic exposure sampling. As K6 latches to the left (Figure 13) its switch section "b" closes the chip motor return circuit, causing it to turn. Section "a" has shifted to position which charges C1 to 28 volts.

Since the initiating circuit is on briefly, K5 contacts remain down only for sufficient time for the motor to displace the one revolution wheel detent from the plunger. The plunger then rests on the outer wheel surface as it turns. During this time the solenoid is de-energized. As the wheel is rotating the chip mechanism is removing one chip from the cassette. This mechanism also positions the counter by one position. This counter stops the chip mechanism from recycling when the selected number of chips has been removed from the cassette.

e. As soon as the chip has been removed from the cassette and the wheel has completed one complete revolution, the solenoid plunger (now de-energized) falls back into the detent.

As this occurs, "S2" has fallen back to its former position (as shown). The return circuit is then broken to the upper winding of K6 and is closed to the lower winding. K6 then relatches to its former position. Section "b" of K6 shifts from ground return to 28 volts. This effectively short circuits the chip motor armature which achieves a dynamic braking action. Section "a" of K6 shifts the charged energy in "C1" capacitor via CR2 to K7 relay, causing its contacts to latch upwards as indicated by arrow. K7 relay, in turn, energizes the dark slide door motor through contacts of K8 relay. It also furnishes a 28 volt pulse to the platen positioning circuit, whereby the platen motor drives all four platens toward the extended position.

f. As the dark slide door has begun to open its limit switch S3 opens, removing 28 volts from the exposure control servo motor. The exposure light sampling had previously taken place and the servo is disabled to retain that position for all reproductions required of that film format. It, therefore, follows that sampling for exposure takes place but once for any number of reproductions. The opening of S3 also removes 28 volts from the shutter allowing it to close. It is seen that the circuit 28 volts is also removed from relays K7 and K9. These two relays has been previously latched in the direction shown by arrows when the door had closed at the conclusion of a previous run. K7 had been latched in ready state for the next operation and K9 reversed the motor for the subsequent opening stroke.

As the dark slide door fully opens, its "open" limit switch S4 applies 28 volts to relays K7, K8 and K9. K7 latches in ready state for the next subcycle, K9 reverses the slide door motor in ready state for closing the door, (this occurs only at the completion of the operation of the run). K8 latches to break the circuit to the slide door motor. This prevents the door from closing until K8 becomes relatched by the grounding of section "b" switches of the K1 - K4 relay bank. This occurs at the conclusion of the run, after the final chip has been ejected from station 4. It, therefore, follows that the relatching ground signal never takes place during operation, because all four of the K1 - K4 relay switches will never be closed until the final chip has been ejected.

Because of simultaneous events occurring when the dark slide door begins to open, it is necessary to briefly return to that part of the subcycle.

As K7 contact "b" furnishes power to drive the slide door motor, its "a" section has transferred stored energy on "C2" to the platen positioning circuit. This circuit is analogous to the initiating circuit; it differs only in time constant. This circuit drives the platen motor for sufficient time to carry all four platens to their fully extended position. As the four platens approach their fully extended position, a limit switch "S6" closes 28 volts power to relays K10, and K11, also to a 1.5 seconds delay circuit. K10 reverses the platen drive motor to be in ready state for the platen return stroke. K11 removes power from the platen solenoid allowing its plunger to detent the platen to the precise position. K11 also latches relays K12, K13, and K23. K12 and K13 remove the vacuum valve solenoid power. This enables the timing of application of vacuum via K1 - K4 relay bank, section "a" switches. These relay contacts then open and close the vacuum valves at the proper time during each subcycle. Since we are discussing the events associated with the first subcycle or a run, only one of the K1 - K4 relay switches will be open, therefore, only Station One vacuum valve solenoid will have been opened. K23 shunts out pneumatically operated switches. This relay is discussed in the following paragraph.

g. During the 2.5 second of delay time, the chip to be processed is loaded on the platen at Station One. Since the vacuum valve for that station is open from the begining of this time period, the pneumatic system is bleeding off through the platen of Station One. This condition would ordinarily remove the dc power and disable the system. The reason is that the system is provided with switches that are actuated by the pneumatic system. The purpose of these switches is to halt the operation of the system in the event any chip fails to adhere properly to its respective platen. Since there are four platens of which any three will be loaded with chips, it follows that each platen must be provided with a pneumatically operated switch. This pneumatic system is arranged such that a loss of vacuum on any one of the platens will release all of the switches the contacts of which are maintained closed by the vacuum. These four switches are series connected as shown in Figure 13 (extreme right). Since the dc power to the system will be broken if any one of these switches open circuits (via loss of vacuum) it is necessary to provide a momentary shunt across this bank of switches during the 2.5 seconds required for loading the chips on Station One. This shunting must be affected on each subsequent subcycle since the chips are ejected at Station Four and the platten is reloaded with a new chip at Station One. This is the purpose of K23 relay. As K11 de-energizes the platen solenoid to detent the platens, it applies a 28 volt pulse to one winding of K23, latching its contact (as shown by arrow) to close the power line, effectively shunting the four pneumatic switches. This maintains power to the system during the loading period at Station One.



Sanitized Copy Approved for Release 2011/05/03 : CIA-RDP78B04747A000800010009-4

At the termination of the time to load the chip (2.5 seconds) the relay contact of the delay circuit closes. This applies energizing power to the opposite winding of K23 which opens the shunt across the four pneumatic switches. If the chip had been loaded properly, the pneumatic lines are prevented from bleeding by the placement of the chip over the platen. If however, the chip does not lie flush to the platen surface, the air will leak through the platen holes and bleed off the vacuum. If this occurs the power line will be interrupted since the pneumatic switches will never close the circuit.

It is important to note that when a vacuum failure occurs as explained above, only the pneumatic circuit which is open circuited will have its respective platen bleeding off the vacuum. While all of the pneumatic switches have open contacts, three of these switches are shunted by the contacts of section "d" of the K1 - K4 relay bank. It becomes more apparent as the operation progresses the importance of relays K1 through K4, for they provide the major timing for the proper events to take place. The contacts of these four relays are covered in review in a later paragraph.

Let us now consider the condition where the chip has been properly loaded to the platen at station one. This reverts the discussion back to the beginning of the 2.5 seconds time delay.

As the platens are driven to their fully extended position, at which time their limit switch S6 has closed the circuit to begin the 2.5 seconds delay, the platen solenoid becomes de-energized, as previously explained. As the solenoid plunger engages into the detent of the platen mechanism, it also shifts a micro switch which applies 28 volts of power to the Exposure Control circuit. This circuit automatically determines the proper exposure time for the respective film format, which took place during the sampling. The design concept for the Exposure Control is discussed under Section 5.6.1.

During the 2.5 seconds delay, the first chip is loaded at station one and the exposure timer operates. Actually, there is no exposure on the first subcycle as this takes place at Station Three. However, the exposure timer operates regardless. After the 2.5 seconds time elapses, the closure of the relay in that circuit relocates K11 and K23 and also furnishes 28 volts power to signal the platen positioning circuit. At the instant K23 contacts remove the shunt from the pneumatic switches, as above explained, the platens begin to traverse toward their former retracted position. The first chip has been loaded and ready to be positioned to station two.

As the platens begin to retract, many events take place which are effective at subsequent subcycles only. Since they always occur at this part of any subcycle however, they are discussed presently for clarification of the functions which are designed into the system.

h. As the platens begin to retract, their respective limit switch, S6 breaks contact 3 and makes to contact 1. This latches K17 relay downward and K18 relay upward. These two relays had previously been latched to the opposite position as shown, as the platens began to extend during the first part of the sub-cycle via S5 limit switch. K18 actuates the pressure valve solenoid for the Air Release Valve. K17 (Sec "a") energizes the drying valve solenoid which is active from the third sub-cycle and thereafter. K17 (see "b") also furnishes 28 volts to signal the Air Release Circuit, (upper left). This circuit is analogous to the "Initiate" circuit, it momentarily applies power to the Air Release Valve. This valve in turn opens, allowing a brief air blast to the processed chip in station four to disengage the chip from the platen. It is apparent that this valve is active only from the fourth subcycle or, at the completion of a full operational cycle. Simultaneously, with the action of the Air Release Valve, the 28 volt signal to the air release circuit energizes a rotary solenoid (Ledex) which actuates micro switch S11. This switch in turn energizes the Chip Holder Transfer motor. This action occurs after chip ejection, at completion of a full cycle. The Chip Holder motor does not operate until the fourth subcycle, since the Film Sensing switch (shown above motor) interrupts the motor circuit in absence of a chip. The limit switches associated with the chip transfer motor (S12 and S13) provides for motor reversal, by alternately latching K20 relay (uppermost left) with each operation. The timing of operation of the chip transfer motor is coincident with the closure of platen switch S7. This switch closes as the platens are in transit and remains closed until the platens are again in transit, being extended during the subsequent subcycle. The transfer motor however, is not in operation the full dwell time; it is stopped by means of a micro switch S11, actuated by the rotary solenoid which ejects the processed chip. S11 is grounded on its normally closed (NC) contact which short circuits the motor armature at turn off, effecting a dynamic braking action.

With each full operation of the chip transfer motor, the closure of limit switch S12, which latches K20 relay downward, also activates the Indexing Circuit (uppermost right). This transistor (Q6) controlled circuit momentarily energizes its relay, K21 for a brief time period. The relay contacts of K21 furnish energizing power to the Index Motor Solenoid which lifts the solenoid plunger from the detent of a one revolution wheel. This configuration is very similar to the chip mechanism which operates from the initiating circuit. As the solenoid plunger lifts from the detent of the wheel it also activates S14 micro switch. This switch in turn closes the circuit to the Chip Holder Index Motor. The motor drives until the wheel has rotated one full turn, at which time the solenoid plunger (which at this time is de-energized) falls back into the detent of the wheel. The mechanism stops abruptly, although the motor, having been de-energized, will be allowed to coast to a stop through the slip clutch.

Simultaneously with the stopping of the indexing mechanism, limit switch S15 closes which latches relay K22, the contacts of which reverse the polarity to the drive motor to be in ready state for the return transit.

i. As the platens have approached their innermost (retracted) position, S5 limit switch breaks contact 3 and makes to contact 1. This closure latches K10 relay which reverses the platen drive motor in ready state for the next operation. It also latches K15, relay contacts downward as shown by arrow. Contact section "a" of K15 applies power to the turret drive motor which rotates the Turret one quadrant, (90°) and simultaneously energizes the turret Detent Solenoid. As the turret completes one quadrant, a cam on the turret activates switch S8 which shifts its contacts to the position shown. This switch performs two functions. It activates K15 back to the position shown, whereby its "a" section removes power from the turret drive motor and its detent solenoid and grounds the motor armature effecting a short circuited armature abruptly stopping the motor. A rectifier is shown series connected to the solenoid. Its purpose is to allow rapid action of the plunger when K15 contact grounds. Section "b" of K15 energizes the liquid spray solenoids which open the spray orifice to the film.

The second event which occurs as S8 switch is closed by the turret, is the signal to recycle. As shown, the "a" section of K1 - K4 relay bank carry the 28 volts from S8 through, once any one of the relay contacts have been closed. It was previously explained that one of the relays must latch in the direction to close these contacts as soon as the initiate switch is pressed. It is therefore, clear that the 28 volts furnished from S8 passes through, once any one of the relay contacts have been closed. It was previously explained that one of the relays must latch in the direction to close these contacts as soon as the initiate switch is pressed. It is therefore, clear that the 28 volts furnished from S8 passes through, for example, K1 Section "b" contacts (it could be any one of the four relays that had closed) and terminates to "R" a series resistor at the input of the initiating circuit. This starts up the chip motor to begin a new subcycle. This same 28 volt signal is also connected to section "a" contacts of relay K16, which are at this time in the "up" position. The "a" contacts are therefore, open, and nothing occurs at this time. At the completion of a run of chips K16 is shifted to the position shown. The drawing illustrates all relay positions prior to the start of the run. The purpose of K16 relay is to furnish three additional subcycles after the last chip has been removed from the cassette. In other words, when the last chip has been loaded, it begins the first subcycle of the final full cycle. K16 continues the operation of the system to complete the full cycle. This is discussed in greater detail in a later paragraph.

j. We will now discuss the repeat signal operation, neglecting for the time being the function of K16 relay, since it performs no function at this time.

Each time the recycle signal is received by the closure of turret switch S8, the same chain of events takes place. It is important to recall that with receipt of each signal to recycle, the initiating circuit actuates its associated relay, K5, whereby the "a" contacts of that relay closes a grounding circuit to station one switches. These in turn latch one of the K1 - K4 relays with each recycle. Let us assume that four chips have been selected for print reproduction. The first subcycle is initiated, manually, via S1, as previously explained. At this time K5 energizes the chip mechanism solenoid to remove one chip and also furnishes a grounding pulse to station one switches, one of which is maintained closed by a button cam on the turret. All switch contact sections of one of the K1 - K4 relays will latch opposite to that shown "a" section will close "b" section will open "c" section will open and "d" section will open. At this time however, we are concerned only with sections "a" and "b". With any one or more of section "a" contacts closed a recycle signal will occur, since all four relay sections "a" are parallel. With any one or more of sections "b" open, (b" opens as "a" closes) a ground circuit is interrupted to the Dark Slide Door "interrupt" relay, K8, to vacuum solenoid relays K12 and K13 and the pneumatic switch shunting relay K23.

The next recycle signal performs the same chain of events. This time however, the turret has moved one quadrant further. The grounding pulse from K5 contacts is applied to switch 2 and the second relay latches. This time two of the K1 - K4 relays have shifted their contacts. Again, after the usual events have taken place, the turret moves the first chip to station three and S8 has furnished another recycle signal. As before, K5 produces another grounding pulse, this time shifting the contacts of the third (K1 - K4) relay. There are now three "a" contact sections closed and three "b" contact sections open. Once more the turret moves one quadrant to station four and again S8 furnishes a recycle signal. This time however, a cam at station four actuates one of the switches located at the station. This switch grounds the first relay which was actuated at station 1 and relatches it to its former contact position. We have now the condition where the fourth recycle signal has shifted the fourth relay to close contacts "a" and open contacts "b" while at the same time the first relay has been relatched to its former position. With any number of chips therefore, after one full cycle has been completed, three of the four K1 - K4 relays will always be in a contact position opposite to that shown. Three "a" sections will be closed and three "b" sections open. This will continue until the final chip has been placed on the platen. Each time the turret rotates one quadrant after the first full cycle, No. 1 chip is ejected at station four as No. 4 chip is being loaded at station one.

k. It is necessary at this time to revert back to the chip counter. It becomes apparent that once the last chip is loaded to the platen, the turret must rotate through three more quadrants to complete the processing of the chip. The recycle signal produced by S8 turret switch cannot henceforth activate the initiating circuit since this would remove a chip from the cassette.

During the normal operation, from the time four chips had been assumed to be selected, the chip mechanism had moved to chip counter arm one digit with each loading of a chip.

This is the condition where the "units" selector is set on "four" and the "tens" selector on zero. It is shown on the counter circuit that the moving arm of the units selector is grounded. All of the moving arms of both the selector switches and the counter are series connected and all stator contacts of the selectors connect to the same number stator contacts of the counter. Therefore, when the counter arm moves to the same number as set in on the selector a ground circuit is made. It therefore, follows that with No. 4 selected, a ground takes place as soon as the chip mechanism has removed the fourth chip from the cassette.

As soon as the counter arm becomes grounded, relays K14 and K16 contacts shift to the position indicated by the arrows. Both shift downward. K14 energizes a "zero reset" motor which returns the counter back to the zero position. As the counter homes to the zero count position, a limit switch S9 closes to contact 1, the position shown. This relatches the contacts of K14 upward which de-energizes and brakes the homing motor. Simultaneously S10 limit switch grounds the initiating circuit, to inhibit its action. This prevents the recycle signal from S8 turret switch from starting the chip mechanism motor.

At this time, K16 contacts have closed from the ground which previously took place on the counter. The next subcycle signal (this is the second part of the final full cycle) passes contacts of K16 relay and directly couples to a 3/4 second delay circuit. This circuit delays the signal to the platen positioning circuit by the same time that would be required for the chip mechanism to complete its duty cycle. By so doing, the duration of the last three subcycles is the same as all previous subcycles.

After elapse of 3/4 seconds, the platens operate in the usual manner. However, since the initiating circuit at this time is inoperative, K5 relay does not furnish grounding pulses to operate any of the K1 - K4 relays. It therefore, becomes apparent that with each of the final three subcycles, one of these relays is energized at station four, shifting their contacts back to the position shown. At the fourth and final subcycle, all of these relays will have been shifted. When

25X1



this occurs, the "a" section contacts will all have opened, interrupting the recycle from the turret switch S8. All of the "b" section contacts will have closed which completes their circuit to ground. This completes the DC power return to K8, K12 and K13 relays furnishing a latching pulse to their contact windings. K8 relay had been latched in the opposite contact position at the beginning of the initial subcycle. This relay interrupted the Dark Slide Door motor to prevent its closing during the operation. At this time, the closing of "b" section contacts of K1-K4 relays closes the circuit to drive the motor and close the Dark Slide Door. K12 and K13 relays energize the vacuum valve solenoids, which inhibits the vacuum system to the four platens. The other two contact sections of K1-K4 relays were discussed previously. To restate their function in resume, section "c" contacts enable the vacuum only during the time the chip is flush to the platen to prevent bleeding of the air system. From station four to station one there is no chip on the platen since it is ejected at station four and reloaded at station one. The relay associated with any platen at station four will always be in the contact position which energizes the vacuum valve solenoid (Section "C" closed). Section "d" contacts provide shunting across the respective pneumatic switches in the same timing as Section "C". As previously explained, all pneumatic switches are series connected and, therefore, any one will remove system power if its contacts open. The pneumatic system is arranged such that these switches are open circuited whether or not the vacuum valves are closed. It is only the presence of a chip on the platens which enables these switches to close. Section "d" contacts close the respective platen section switches until all platens are loaded with chips. During an operation only the contact of station four will be closed. This is during ejection time of the chip and the transit time of the turret to carry the platen from station four to station one for

 25X1

reloading. As the last of K1-K4 relays have relatched to the position shown the Dark Slide Door closes and the system has completed the run. It is now in a ready state for a new operational run, the first step being to reset the chip selector for the desired number of chips.

## SECTION 10

## MECHANICAL CONSIDERATIONS

### 10.1 STATEMENT OF THE PROBLEM

From the mechanical point of view the majority of problems encountered are centered around taking the necessary basic configuration which would allow all events to be conducted in their required time. By time, we mean not only those parameters established by number of prints/minute, but also internal system times; i.e., length of exposure, data recording as related to mechanical motion, etc.

Basically it would be necessary to produce a unit which could:

a. Select, in sequence, one of 500 individual chips of varying thickness from .003 to .012 of an inch without marring the surface in any way.

b. Position each chip for three separate exposures on the same chip which would mean separately blanking appropriate areas so one exposure does not overlap another area.

c. Generate for one of the above exposures random alphanumerical characters as well as a digital display. Which must be held to extreme tolerances both in printing density and position.

d. Display for exposure, in two separate simultaneous position (1) of up to (99) separate security classifications.

e. Position the input film from the nadir reference up to any position throughout a 9 x 50" format with correct angular rotation to within 1/10 of a degree and X and Y to the best position we can achieve greater than an accuracy of 1mm.

f. Position the chip to the required point on the input film with a possibility of three separate output formats each with a different center. Without losing the above accuracy.

g. Produce a correct exposure over a density range of .3 to 1.8 and exposed while submerged in a liquid gate. Resolution capabilities should be 400 lines/mm.

h. Break the seal produced by the liquid gate and remove the film while rapidly drying it.

i. Place the dried chip in a supplied chip holder and then place the chip holder in a storage magazine.

j. The above covers most of the basic problems others as auxiliary exposure, magnified viewing, slew speeds of input film up to 120'/minute are also required.

All of the above must be done with printing possibilities up to 10 prints/minute, or each and every item A through J, above, must occur every 6 seconds.

## 10.2 DIFFERENT METHODS STUDIED

It soon became apparent that in order to fulfill the necessary requirements that the problems must be considered in their entire entity. Thus, time sharing as many functions as possible. The simple platen that would pick-up one chip and move it through various stages became impossible especially if the exposure time alone was considered.

The second approach attempted was to utilize a dual shuttle along with a series of vertical platens. Thus, as one-half of the shuttle picked up a chip, the second half gave it up to a new platen in a different position.

Unfortunately, such an approach became unwieldly and positioning accuracy became a problem, but the main problem became the three random format sizes which required rotation and translation for each individual print.

The third approach was a large flat wheel with four individual holders. Thus, the chip would be ejected into position one. The wheel rotates to position two, where the platen pushes the chip through the wheel to the exposure position. The chip makes contact with the data recording tape, is exposed and then returned to its former position in the wheel. The wheel would then rotate to position three, the same procedure would occur. The wheel then advanced to station four, where the chip would be ejected in the chip holder loading station. During all of the above operation, four pieces of film would be in operation at one time.

Unfortunately, a wheel of this type by necessity had to be approximately 20" in diameter, (two, five inch films, back to back, plus necessary clearance). The thickness of the wheel, although held to a minimum still needed body, just to support its own weight. These together produced a high rotational inertia which was far from practical. Numerous other problems became apparent such as, holding the film on the wheel, with the required mechanism to push it through swinging doors, and to close after pulling back. Simplicity demanded we attempt another approach.

In all of the above approaches, it had been assumed that both azimuth and the three format positions should be controlled in the magazine, with just the chip being moved. However, if the chip was rotated for the pictorial presentation it had to be derotated for the data presentation. Thus, for each individual exposure various degrees of rotation had to occur and similar derotation for each individual exposure.

Likewise, if the print format area changed and its resulting center, then a dual translation had to occur twice during each print.

To overcome the above, the rotation was placed below in the input station and even though the mass to be moved is large, it need be accomplished only once when repetitive prints are to be supplied. The format change has been accomplished by placing the center of the magazine over the three different optical print centers. This requires three separate positions for the magazine, but does free us from an automatic, complicated mechanism as well as a tremendous operational time factor, which would otherwise be required.

The above two factors along with the concept of a vertically mounted rotating wheel, both with its smaller size, relative low inertia and the freedom it gave us to position both data recording and the chip eject mechanism has therefore, been the approach pursued.

By utilizing all four platens at one time, it is now felt that the overall time requirement of 10 prints/minute is possible. Even if only 5 prints/minute was required, this would, for many other factors explained later, be the better approach.

25X1



## 10.3 FILM CONSIDERATIONS & OPTICS

Initially it was felt that an optical projection system would be required in conjunction with the exposure lamp. However, investigation soon showed that any system contemplated would require a highly parallel beam in order to maintain the required resolution.

Unfortunately, the more parallel the beam, the greater the output material would be degraded by dirt and dust particles which would to some degree always be present on the optical surfaces. Therefore, the fewer the glass surfaces the better.

Testing, as shown in the latter part of this section, showed that if the filament size of the bulb was kept small and placed a reasonable distance away from the image plane, resolution would not be degraded by lack of an optical system. Furthermore, dust, scum deposits, glass surface striation etc., could be reduced at the image plane.

The testing results of the above are in this section under the title "Filament Size" and "Resolution VS Distance". Testing for maximum resolution was attempted on various films. It is now felt that the final unit will be capable of better than 400 lines/mm provided a suitable input film is utilized and the output film has the capability to produce it.

However, resolution alone does not specify the criterion for a good output reproduction. This must be a combination of tonal reproduction, acuity and resolution. Obviously these in turn are affected by the film grain size, emulsion thickness, type of emulsion, light source, many factors in development, and even the drying of the output film.

To resolve the above into terms of a specification that we can produce in this unit, and also give user satisfaction, becomes extremely difficult if not impossible at this time. Therefore, we feel the unit with a satisfactory input target will meet the original requirements of producing 400 lines/mm if the output film has these

25X1

capabilities; and it is developed under Eastman Kodak's standard recommendations. Second, the tonal gradation will be held to as little distortion as possible without loss of detail or acuitance. We realize these are nebulous terms, however, our intentions are to hold to the requirements of the original RFQ, and also to attempt by further study, to clarify both the original intention and to expand these to give the best reproduction possible.

A final test specification will be supplied for customer approval at a later date which should resolve all of the above.

- Filament Size and Resolution VS Distance

In response to request from the Data Processing Section for information on factors affecting resolution in a contact printing situation, a test program was undertaken. The object of the effort was to determine the relationship between source size, source to object distance and the ability to reproduce a square wave resolution target at or greater than 400 lines/mm.

- Analysis and Approach

The general approach to the experiment was to produce a series of contact prints by exposure to a source of known size, varying only material distance and time. In order to minimize the effect of the receptor material or the results of the data, a material exhibiting a high modulation transfer in the 400 lines/mm region was necessary. In order to minimize the effect of processing the receptor material should be relatively unaffected by processing. A slow receptor material has the advantage of reducing the required accuracy of exposure time. A material which exhibits those

25X1

characteristics is diazo. An ozalid material designated Unit Gamma Microfilm, is capable of recording in excess of 1000 lines per millimeter, the gamma of the material is unaffected by processing, and the material is slow. In addition, the sensitivity of the material is limited to the near U.V. and extends only a short distance into the visible spectrum. The material is unaffected by exposure to room light which alleviates many handling problems.

Exposing Source

The exposing source must emit in the U.V. In order to minimize the size of the test bed, the physical size of the source should be small. A Super Pressure mercury lamp was selected for an exposing source. The particular lamp selected is an OSRAM, H B 0200W. The size of the arc is 0.087 inches x 0.024 inches.

Target

The target should be a high contrast square wave target having a medium resolution of 400 lines per millimeter. The target selected was a 200X reduction of a standard USAF resolution target. The minimum frequency is the 50 lines per millimeter and the maximum is approximately 700 lines per millimeter. The target is on a 649 GH emulsion and is a film chip approximately 3/8" x 1/2".

Processor

The processor selected was the Ozamatic aqueous

 25X1

ammonia unit. Each exposed strip was wrapped with tissue paper to improve uniformity and was cycled through the unit five times to assure completion.

Test Bed

The mechanical support, devised for the sine wave analyzer, was utilized as a test bed. The main structure was a six foot lathe bed supported on three pointed pylons of alternate layers of bricks and rug pads.

Film Flattening

A vacuum platen was procured and connected directly to a vacuum pump. Initial tests indicated excessive vibration was being produced by the vacuum pump. An accumulator was introduced between the pump and the platen. This reduced, but did not entirely eliminate the difficulty. The vacuum plate was abandoned and mechanical force was substituted to assure flattening.

The procedure followed was as follows:

Procedure

1. Determine dimension of arc

2. Make a series of contact prints on diazo with the arc positional 10" from object. Vary the exposure time in full stop increments after a trial run to determine approximate time.

3. Process in diazo processing

4. Read and record best resolution both horizontal and vertical.

5. Repeat steps 2 through 4 with arc positioned 20" from object.

6. Repeat steps 2 through 4 with arc positioned 40" from object.

7. Repeat steps 2 through 4 with arc positioned 80" from object.

Results

1. Exposure

2. Vacuum vs. mechanical pressure

3. Effects of dust and improper seating

4. Interval Distance

5. Graphs

    a. Resolution vs Pressure
    b. Resolution vs. Distance

6. Off-axis deviation

7. Comparison of diazo against EK105 and Ansco Microdot

Exposure

The exposure was determined by a sequence of variable time shots all taken on Diazo chips at a distance of 10 inches. From a group of variable times, namely, 5 minutes, 10 minutes, 15 minutes, 30 minutes, 45 minutes and 1 hour exposures, the 30 minute was thought to be most efficient. For each corresponding greater distance, an approximation of roughly four times (+ in time) when a uniform doubling of (d - distance) was maintained. Proper exposure was sufficient with this rule at hand for the larger distance intervals, i. e., 20", 40" and 80".

## Vacuum Vs Mechanical Pressure

Flattening of the target chip was known to be difficult. The approach first given priority was concerned with vacuum techniques whereby air pressure flattened the target chip against the platen. Exposure made in this manner gave multiple images and limited resolution to not much more than 250 lines/ millimeter. This was attributed to the vibrational motion travelling from the vacuum pump to the platen. Attempts with a bell jar as an accumulator did not succeed in dampening vibration to a reasonable limit. Tests continued with direct mechanical pressure which was later resolved to a necessary 4. 5 lbs/sq. in.

## Effects of Dust

Dust and dirt particles could conceivably be rendered important. Such minute particles can on occasion raise the target or some part of it, off the emulsion, hence, preventing good surface-to-surface contact.

25X1

These particles, therefore, in addition to preventing the absolute flatness that is so critical, may if strategically located obscure also some part of the transmitted target itself. The results of such contact are always distortion and/or multiple imaging. Observations of test exposures revealed such irregularities with the optically flat platen.

## Interval Distance

The greater distance, as anticipated, yielded the best resolution of somewhere around 500 lines/mm on Diazo material. Characteristics of this greater distance exposure was a distinctly clearer outline of each of the target areas. Exposures for the 20" and 40" intervals were nearly as good. The 10" interval had a resolution of about 448 lines/mm and slight shadowing around the +.01 groups. The geometry break was determined at about 7 inches from the lamp with an exposure of about 8mm. Each of these results were reproducible.

## Off-Axis Exposure

One important consideration in this study was related to the effect of exposure when the lamp source was not directly on-axis perpendicular to the target. Exposures made with a 5° deviation from the center on-axis line (i.e.; each corner of the platen) showed no appreciable difference from an on-axis shot both with respect to shadowing or resolution. This should dispel concern, if under some uncontrolled circumstances the contact prints are not made under the desired axis alignment.

Diazo Vs. EK-105 and Ansco Microdot

Early tests included results determined entirely from Diazo material. Resolution was in the neighborhood of 400-500 lines/mm and could be reproduced. However, this is not unusual for Diazo and the capability of emulsions such as, EK-105 and Ansco Microdot film were of deep interest too.

An exposure study was made for the EK-105 emulsion and found to require an Eastman Kodak No. 96 Wratten filter of 2.1 Neutral Density with an exposure time of 9 seconds. Exposures of such short duration, of course, usually present some difficulties as in this case. Since the Osram lamp could not be pulsed, it was, therefore, necessary to procure a shutter device - in this instance, a plastic shutter operated by an air squeegie. The apparatus worked for a short period, but began to melt under the intense heat of the U.V. lamp. Later a small hand operated sliding lid was improvised which, in general, worked quite well. Processing was accomplished in the standard (3 minute), D-19 developer and rapid fix. Best results were approximately 400 lines/mm on and off axis as shown on Graphs I and II.

## 10.4 DETAILED OPERATIONAL DESCRIPTION

Note: Following in Section 10, each individual section of the entire unit is explained in detail. Accompanying layout are enclosed and referred to for ease of explaination where necessary. These are not assembly prints, but design layouts which in most cases are ready for actual design to start from.

### – Overall Configuration

The overall unit has been illustrated as an artist's rendition in Figure 1. As this concept has been generated from actual layouts, the final configuration is not expected to change considerably, and only in the following areas.

a. Chip Holder Magazine

b. Display and Controls

The chip holder magazine position may change because of lack of interface drawings. Therefore, in order to complete our design we have assumed a possible configuration.

The Display and Controls will be located in the positions as shown. However, the exact layout has not been firmed up and cannot be for some time. Primarily, because individually designed components need to be worked out during actual design. Secondly, a more thorough human engineering concept will be conducted after all design sizes are established in agreement with the customer's requirements. However, it is felt that more than sufficient space has been allocated to produce the effect required.

From the original concept until now, it has been felt that at least two exposure stages of operation were necessary, primarily because it is impossible to blank the data area and reprint at the same time actual imagery is being produced in the format area. Some position had to be utilized for start of cycle and another for end of cycle or eject of chip. These factors lead us to a basic four stage cycle. Some early history of this development is covered in Section 10.2.

The existing designs required to meet all design parameters are illustrated in Figure 14-20.

— System Description (Magazine)

Normally the magazine is at rest in the back position. After the input film has been placed in its proper position, the magazine is brought forward to one of three detent positions, depending upon format size required. If the auxiliary exposure control is to be utilized, this must be positioned first, (see exposure control and auxiliary viewer).

### 10.4.1 Electronic Console

The electronic console is illustrated in its logical position in Figure 1. Mechanically, very little can be said about this except that the digital logic, power supplies and all those items covered in Section 5.1 through 9.2 will be located for the most part in this section. In the back of the electronic elements will be located the vacuum pumps and liquid storage which will be utilized in the main console.

This unit, although part of the overall console will be manufactured and constructed as an independent unit which will be positioned through vibration isolators to the main print console. This allows us freedom both in manufacturing, assembly and in final testing. Also, it maintains all those items with the exception of the exposure light system which will generate heat in one separate console away from the main unit. In the long run, because of ease of manufacture, this should be a saving in time and cost.

### 10.4.2 Print Console

The print console is depicted in the artist's rendition of Figure 1 and in the overall layout as illustrated in Figures 15a and 15b.

The print console is discussed as that item which handles all of the film input and output material. For ease of description, this has been broken down primarily into three sections called the Print Console (or lower frame), Magazine, and Controls and Display. This entire item is independently mounted on air bearing, vibration isolators. During all printing operations as far as possible all internal vibrations are held to a minimum by independently closing down all operating items such as motors, gear trains, etc.

– The Film Input Section

The film input section consist of the Azimuth and Pedestal the Z Axis, the Illumination System, the X and Y Drives.

The input film may be loaded into this console by rotating the azimuth so that the film may be loaded from the front. The entire unit is then rotated 180°

and the input film is attached to the take-up spools. The doors are then easily closed and the entire unit is light tight for all future operations.

Azimuth and Pedestal

As seen from the illustrations a channel base welded structure supports a pedestal upon which are mounted through two individual ring bearings the external supporting mechanism for the azimuth X and Y drives.

In actual operation, the azimuth can rotate a full 360° during which time it carries the various spools which have been loaded into the X frame structure. Independent shaft encoder will read back the azimuth positioning to one-tenth of a degree from a reference 0 and display same on the front control panel. This rotation may occur regardless of what offset exists on the X or Y axes.

Shutter and Light Source

Internal to the azimuth pedestal is located the shutter and light source. The light source is located approximately 20" from the film plane in order to give a sufficient parallelism to the light to maintain resolution. Unfortunately, this light requires a small filament size with high intrinsic brightness. At the moment, the only bulbs which seems to suffice in this area are those of the liquid, mercury type. Although it would be desirable to be able to pulse these lights for exposure control, this does not at the moment seem feasible, as most mercury arcs require a certain starting time, during which their illumination is neither constant nor steady. Although further investigation will be conducted in this area, it is now felt that a capping shutter may be utilized to control exposure. This is directly above the light source and of

Final Report of Phase 1
Program 105
30 January 1965

25X1

the simple, two blade type. This should suffice as a high shutter efficiency is not needed because of the extreme relative long time exposures.

Film Format Mask

Located at the top of the pedestal in the center of the azimuth drive and directly between the take-up and supply spools is located the film format mask. This is located in the center of the pedestal and is attached to the stationary portion which does not rotate. Therefore, it is always kept in precise alignment with the magazine positioning turret above.

By proper selection of one of three input masks the same central area is always under control in reference to the optical center. Exact details of this mask are not at the moment completed. It is anticipated this shall consist of 12" piece of glass, an appropriate center section blocked out and image area and fiducial marks correctly located.

An attempt is now being made to place individual lines outside of the format area so that the format of the input film may be brought into registration. This allows registering all input films to the index mark at the zero rotational positions. This does not present any difficulties in the tape mode but may be a distinct disadvantage in the manual mode.

Directly below the mask and external to the pedestal will be auxiliary lighting. This will be of the

25X1

fluorescent type or cold cathode type which will illuminate the entire format area for general viewing.

X Drive

Although both the azimuth and Y drives are relatively simple, both in configuration and details, the X becomes relatively complicated. This consists of two spool holders on each side of the format which service film sizes from a 9" roll, two 5" rolls, or two 70mm rolls of input material.

In most positioning systems, it is customary to always clamp the film in a form of carriage and then move the carriage when precise positioning is required. Because of the accuracy necessary here, this would have normally been the logical approach taken, however, the requirement of a 50" frame would have made the overall machine tremendous and highly impractical in this particular design. Therefore, based upon previous design experience and actual construction that FCI had achieved in film drives utilizing nothing more than a precise metering system, it was felt that the positioning accuracies could be achieved by this method alone. However, as this was an expansion over the present design by some magnitude, this system was breadboarded and tested.
It would be noted that the control on this system requires both a velocity control and a positioning control. Both of these are not normally developed in the same system. We decided earlier that this was possible

25X1

and quite feasible. The breadboard results have been completely satisfactory.

To understand this drive system, it is necessary to consider both the supply and take-up spool at the same time. A torquer motor is placed directly in line contact with each of these sppols and each is constantly turned through a biased voltage in opposite directions. The torquer motor was selected for numerous reasons. First, direct coupling allievates the necessity of a gear train. Secondly, their infinite positioning resolution allows for extremely good servo control, and third, their low inertia to power requirements.

These two torquers are now biased so that a constant tension remains in the center of the film at all times. This is controlled by a sensor arm which determines the change and film roll size constantly as the film is transferred from one roll to another.

As an additional voltage is applied to either torquer the system is thrown out of balance and driven toward the side of greater voltage. This then becomes our velocity servo as increasing voltages produce increasing speed. Fortunately, by removing this voltage and at the same time shorting out the torquers, a braking action is produced which stops the film almost instantaneously at any speed. The positioning servo which is fully described in the electronics section of this report operates from the same individual torquers when the mensuration mode switch is depressed.

During mensuration as the film passes from one spool to another in either direction, pressure contact

 25X1

wrap
by the [redacted] of the film around a metering roller, constantly positions a thousand count shaft encoder. This shaft encoder acts as the feedback member to determine through the digital electronic drive exact positioning to an accuracy of better than .012" per 25" of travel.

Y Axis

Directly above and hanging from the azimuth pedestal is the Y drive. This supports the entire X drive and both units are moved as one while supported upon two Thompson ball bearings and driven by a Saginaw lead screw. A shaft encoder acts as the actual positioning device and control feedback to the electronic control.

Exhaust System

No provisions were made in the original concept of this machine for a separate exhaust for toxic fumes. However, for safety precautions this will now have to be added. It is anticipated that at this writing it will be necessary to interlock this with an exhaust system supplied by the customer so that it can be piped externally from the building.

 25X1

## 10.5 MAGAZINE

### 10.5.1 Detailed Operational Description

The term magazine shall for purposes of this discussion refer to that mechanism which handles the complete operation of the output material. In turn, this has been broken into various sections for ease of description; namely,

a. Cassette; holder for raw film chips.

b. Magazine Turret; removes chip from cassette and positions it at the data recording station, print station and eject station.

c. Data Recording; applies security information, alphanumerical and digital bits to film chip.

d. Print Station; position where image is exposed contacted in a liquid gate.

e. Ejection Mechanism; position where film chip is ejected from the magazine turret, placed in chip holder and holder placed in holder magazine.

Once the magazine is located in the proper position an indicator lamp shows format size and the print indicator comes on.

If the number of prints and security classification has been set by the tape input, printing may commence, otherwise they must be set in. Printing is now started by pushing the print button.

25X1



The printing cycle operates as follows. The first platen in the upper position goes up and receives a chip from the cassette ejection mechanism. The platen is retracted and the turret rotates to stage two. The platen moves out and data recording and the security classification are exposed. At the same time platen number two is picking up a second chip.

The platens now move back to the rotation plane and the magazine turret rotates to position three. The platen starts down as jets of Freon cover the surface of the chip and the top and bottom of the input film. The exposure is made.

At completion of exposure the lower input film is blown away from the printing frame. (This is necessary so the films do not stick together). The platen retracks to the rotation position and the turret rotates to position four where the chip is blown free of the platen by air pressure.

The chip ejection mechanism now moves the chip into a chip holder and then the chip holder into the holder magazine.

Proper safeguards are located within the magazine so that malfunctions are indicated on the front panel and the operation stops.

## Exposure Control and Auxiliary Viewer

The electrical considerations for the exposure control are discussed in Section 10.2. Mechanically, two separate exposure controls are provided and either may be utilized.

Under normal negatives and normal operation the exposure photo cell is located on a shutter door, directly under the turret, and senses the illumination requirements when the magazine is located in the printing position. The door also acts as a light shield for the entire magazine when the magazine is not in position.

Once the exposure has been determined (the magazine is light tight in the printing position) the illumination shutter closes and the door opens allowing exposure to start.

The auxiliary exposure control and viewer are located on the front of the magazine. These are utilized when a very small area on the input film must be determined for exposure. An example would be ground terrain as seen through a heavy cloud area. An average exposure (normal) would be so far from correct that the ground area (especially if the area was extremely small) would be useless.

The auxiliary viewer can be placed over this area and the exposure control so determined.

The auxiliary viewer will produce approximately a 10X image that (same as that seen by the photo sensor) can easily be seen by the operator.

Seven buttons are also provided on the main control panel. These may work in conjunction with either photo sensor. The middle one in all cases is the normal exposure as determined by the photo sensor. It is anticipated that each button will raise or lower the exposure by 1/2 stop from the normal. However, if this is found inadequate they can be set to 1 full stop each.

— Various Size Formats

As previously discussed in Section 12.4, the requirements for various size formats must be set once for each identical group of prints, separately and independently from the internal operation of the magazine.

 25X1

Whereas, each chip format not only varies in size, but also moves to a new center position. We can, therefore, use the center position as a constant which must always be aligned to the optical printing center.

Therefore, as the magazine is brought forward into its printing position the operator will be allowed to select one of three printing formats. This is accomplished by individual detents. Thus, when the locating pin drops into its selected hole it energizes a switch which displays on the control panel that format size he has aligned to. Thus, the position of the magazine is varied with respect to the optical center of the projection to produce a direct alignment with the optical center of the selected chip.

Also, various individual masks must be changed at the printing area. See Figures 1 and 14, a separate slide drawer at the top of the electronic chassis is provided for storage of individual masks.

Unfortunately, these masks must be made the entire size of the viewing area in order to insure that the liquid utilized in the liquid gate does not drop or drain down into the lower mechanisms.

These masks may be changed quickly and with ease, but being glass, moderate care must be exercised to reduce breakage. It should be noted, that these glass masks must be kept clean at all times or the resultant dust, dirt, or scum will appear in the reproduced image.

## Chip Turret

The Chip Turret is illustrated in Figures 16 thru 18 [redacted], [redacted]. Four platens are mounted on equal quadrants around a center axis. Each platen is held in position from a central casting support and the cam follower arm. Two torquer motors supply all necessary functional motions. In Section A-A in the upper right hand corner is the turret rotation motor. Its function is to rotate the entire turret in 90° increments.

 25X1

The second motor illustrated in the front view shows the position of the cam rotation motor. After each 90° increment is achieved, the cam rotation motor rotates the cam and the cam follower, in turn, displaces all four platens outward. With the platens in the outward position, the various operations such as receiving the chip data recording, image exposure, and chip ejection is accomplished. When these are completed the cam rotation motor rotates in the opposite direction bringing the extended platens inward to the rotation position. At this time, the rotational motor then proceeds to the next 90° position and the cycle proceeds.

In Section A-A are shown numerous seals. To the left of the view are shown the rotational vacuum seals. Thus, a vacuum input from one stationary line is individually piped to each individual platen in Stations 1, 2, and 3 (chip pick up, data recording, image formation). The vacuum line serves to hold or maintain the chip always in contact with the individual platen. When the platen is rotated into Station 4, then the line is switched from vacuum to pressure and the chip is ejected into the chip ejection mechanism.

Various electronic interlocks are combined with this turret so that a power failure or other anticipated failure, which drops the chip, automatically energizes a vacuum pressure switch that stops the entire operation. The operation will also be stopped if at any time the chip fails to set properly or inadvertently is forced out of position. Obviously, this malfunction must be safe-guarded against and the operator will be warned by both an indicator light and a buzzer connected to the front control panel.

The turret mechanism is a part of the overall magazine. Although for assembly purposes, it is an entire entity by itself.

25X1



## Film Positioning to the Turret

Because of the extreme tolerances a thirty-second of an inch across the narrow dimension, and a one-sixteenth of an inch across the wide direction of the film chip which is left by initial cutting of the film manufacturer. It is necessary to establish a constant position somewhere. Basically this could be done in two ways. One, by banking to two right angle surfaces. Unfortunately, mechanism-wise this becomes somewhat complicated. An easier procedure and the one which has been followed is to consider the center of the optical image formation as a constant, which we then establish all dimensions to. By so doing, it is now quite possible to locate a chip as it drops from the cassette onto the upper platen with a relatively wide tolerance. However, we now must maintain the center so that the platen is in direct line at all times with the optical center of the printing system. This registration must also be maintained for the data recording and security classification. The end result will be that all displays will be equal about the format which is centrally located about the fiducial marks which exist on the printing mask. At this particular moment this is the only close tolerance build up that must be controlled throughout the entire mechanism.

## Cassette

The chip cassette is a self contained entity which may quickly be detached from the overall machine for darkroom loading. Cassette loading is the only function which must be accomplished in the dark.

The Film Chip Cassette is illustrated in Figure 19. Various methods were tried at removing one individual chip from a stack of 500. Initially it was felt this could be accomplished by a combination vacuum and mechanical approach. However, in all cases, the vacuum approach failed to continuously pick up only one chip. This was especially true on the thin base film chips. Therefore, a completely mechanical approach was attempted.

On the breadboard both the storage and removal mechanism were combined together as one assembly. In the actual design layout however, the removal mechanism was made a part of the actual magazine. This wad done because more than one magazine might be needed and the mechanism should not be repeated, thus making the cassette smaller and easier to handle.

The maximum capacity of the cassette has been established at 500 chips of .005 thickness. Thereby reducing the overall size by a factor of 2-1/2 times over that size which would be required for a .012 chip. This was felt reasonable as most chips to be used will be under .005 thickness. The magazine will still accept 200, .012 chips.

The Cassette consists of a box within a box, with one sliding within the other. A film pressure plate is easily pushed back for loading and yet keeps the film to the forward position so that individual chips do not become scratched or banged about between the dark room and the console. A stop is provided for holding the spring back during loading.

A dark slide is provided for a light seal. This must be removed after the cassette is attached to the magazine. If the dark slide is inadvertently not removed, the vacuum interlock will not allow operation and will so indicate to the operator.

After the magazine is clamped to the magazine, two rollers within the magazine come in contact with the lower film chip. The film chip is held in position by the Floxator springs and the two film stops.

Upon demand to print the two rollers rotate toward the center of the chip, bowing the chip with it ;until one chip is snapped out, the rollers then reverse and place any other chip that may have started out back into place.



10,28

The pressure exerted by these rollers is light and under actual tests with live film does in no way mark or damage the emulsion. Actually they touch the film only at the four corners.

Attempts to eject a chip by rotating in only one direction were 90% successful but ran into serious trouble when the cassette was almost empty. However, by reversing the rollers the cassette consistently ejected one chip only.

The slightly curved film weight along with the action of the eject rollers does not allow one film to rub against the other except at the last 1/4" of a chip. Again under actual test no marking of the film could be found.

The layout of Figure 19 is illustrated as it would be with only one chip present.

25X1

## Data Recording

One of the stiffest requirements on this program has been data recording. By the same token, one of the most thorough investigations has been Data Recording. The entire industry has been searched for various possibilities. It is quite apparent that there are recording devices which record at a much faster rate than we need and also record to higher density than we need. However, most of these are computer controlled, extremely large and financially not within the scope of this program. Previous monthly reports have covered a good deal of investigations which have also been made on CRT and Charactron displays. Unfortunately, because of the extremely low film speed and the rapid time which would be required to lay down this amount of information these are, at the moment, impractical. If any one item in this entire program can be considered a state-of-the-art development, data recording is it.

Nevertheless, FCI has developed a mechanical-optical approach which we now feel will meet the existing requirements. For the purpose of this reporting, we are submitting this as a part of the context herein. We are also submitting in Appendix A a secondary approach which is not within the scope of this program, but FCI believes has tremendous growth capacity to the extent that it may eventually become a type of data recording which will be utilized throughout the industry. This is submitted as Appendix A and is not submitted as part of the context because of the price increase that would be entailed for the advanced initial development of this system. Considerable development has already been accomplished on this method under other contracts, and what would be needed here is more of an expansion of an existing system. The one drawback of this system in the early stages of our study was with the initial film requirements of low speeds and orthochromatic emulsions, where this could

25X1

not be utilized because of the spectrum response between emulsions and the silicon light pulser's emittance which would not have allowed us to achieve the required exposure density.

However, because of recent discussions with Eastman Kodak, it now appears quite feasible that we can utilize panchromatic emulsions without degradation of resolution, acuity, or tonal degradation. This system is now practical. It is submitted here as an auxiliary approach which would allow for growth features in the future, if additional data should be required at a later date.

The system which has been supplied within the body of this report should meet all of the existing requirements of this program. However, if additional data was to be required at a later date, expansion would be extremely difficult. We will discuss the mechanical approach in the remainder of this section. Three types of data recording are required.

a. Security Recording

b. Alphanumerical Recording

c. Digital Display Recording

The security recording has nothing to do with the discussion above, but is a separate recording of two images placed on the film which will be laid down by a predetermined mask. Selection of this recording may either be manual input or by tape. This consists of a Mylar tape with imprinted images of the wording to be displayed. This tape is positioned on a supply and take-up spool that is stretched across the chip area for exposure.



16,31

 25X1

The individual selections are arranged in two groups of ten each. So positioned that the wording will read correctly for each side of the chip. The mechanism which controls this is being designed to take up a total of 99 individual security classifications. However, it will be supplied to the customer with ten classifications leaving the remainder for growth or their selection at a later date. After the proper security classification has been positioned, this now acts as a negative and is exposed by flash illumination in direct contact with the resultant chip. This same flash serves a dual purpose and exposes the alphanumerical and digital recording which will be described below.

Only preliminary design has been established for security display and is not displayed in any of the illustrations. The intention here was only to prove feasibility and establish requirement for space tape input control. Design details will be worked out as the program proceeds and no major problems are foreseen.

- Alphanumerical and Digital Display

The basic alphanumerical and digital display is accomplished as follows. An individual mask for the entire display will be made from the tape read-in while the time the input film is being positioned. This mask will be moved into position as the chip material is brought in contact with it at the second stage of turret rotation. A direct contact print is exposed producing a crisp, sharp, detailed display.

Figure #20, illustrates the mechanism that is required to make the original master negative. This master negative will be produced on a product produced by DuPont called Cronapress Conversion Film. This Cronapress film consists of a Mylar base with a raised bubble

 25X1

surface. By applying pressure to this raised surface, the bubbles are collapsed and the film becomes transluscent. Fortunately, this type of a tape does not leave residue, thereby keeping the machine free from stray dust and dirt particles.

The mechanism consists of two basic character generators; one for the alphanumerical display and a separate display for the digital dots. The alphanumerical display is accomplished by a font wheel mounted directly to a synchronous motor. This font wheel rotates with a constant velocity of 600 rpms. When the tape input demands a pulse, a separate timing wheel, mounted on the same shaft displays through a magnetic pick up the position of the character required. A trip magnet located below the Cronapress Conversion Film is supplied from the magnetic pick up, a pulse, which energizes the solenoid which, in turn, fires a free flight hammer which punches the required character. A free flight hammer is utilized here both to eliminate possibilities of bounce and to insure that the hammer is in contact with the character less than a fraction of a millisecond.

A small breadboard has been developed to prove out the above principles. Using a constant speed motor in place of the font and an 80 tooth gear of the same diameter as the actual font. Feasibility has been accomplished which we believe will allow us to produce a clean, crisp character.

Directly in front of the font wheel are eight individual, digital display hammers. The ninth or timing pulse is a fixed hammer always in position. These hammers consist of small protrusions extending below a base plate directly above the Cronapress film. At the start of cycle a one rev cam clears all keys. At the same time individual miniature solenoids latch each individual hammer in the up position As the tape is read in, the appropriate hammers are released by their individual solenoids. The spring loads on the hammers then

25X1

drops the required fingers through the plate below. A fire pulse operates a separate hammer below the Cronapress, similar to that one on the font wheel, only large enough to cover all (9) hammers to hit those displays required. Recycle immediately resets all keys waiting for the next column to be selected.

In order to maintain all space requirements, very precise metering of this tape is required. This is accomplished by a spring loaded carriage which holds the tape in position and by utilization of an escape mechanism positions it precisely to .001 of an inch for each individual step of .030 of an inch.

In actual operation, indexing each .030 step will display an individual digital output through the hammers. The font hammer will be fired every second cycle and will place the character display on .060 centers.

When the entire display has been achieved, the carriage opens and the tape is moved through a right angle pass and placed in the data recording exposure gate. When the platen with its resultant chip is finally placed in position, a flash lamp makes a single individual exposure exposing both this data display and the one from the security classification at the same time. Repetitive exposures are produced by addition flashes.

25X1



## 10.5.2 Film Recording

All film image recording is accomplished at turret stage three or when the platen is located vertically downward. The mechanism which locates it here has been described for the most part in previous sections. However, with the following exceptions, each platen is mounted more or less to a separate platen directly above. Between this upper and lower platen is a ball bearing located on a central pivot. Located around the platen are individual springs located so that as the platen comes in contact with the printing glass, it can shift to maintain flatness and parallelism at all times.

Initial breadboard testing produced a phenomena in this area that we had not anticipated. With the chip on the bottom of the platen and the platen pushed in contact with the input film, then in contact with the glass below and in a liquid gate, the liquid acted as a self-sealant so that the air was successfully pushed out between the three members. In effect we had the old Johanneson block adhering to the surface plate. It was physically impossible to pull the films apart without damage. Numerous methods were attempted and tried to solve this design problem including things as bent platens, attempting to slide the two apart, rolling apart etc. When any of these methods succeeded in freeing the film they, unfortunately also created a registration problem. It was found, however, that if the input film could be blown away from the printing frame that the two films also quickly separated. Therefore, for this reason individual jets are located in the printed frame outside of the image area for this purpose. As long as these were necessary, we are also utilizing the same jets to wet the film in its initial stage.

With the film in registration it is anticipated that the exposure will take two seconds or less depending upon the density of the negative or of various types of input film. Besides the jet sprays coming from below, the input film jets will also spray the chip and the top of the input film, upon release from the platen area, air pressure jets will attempt to quickly dry the film.

Appropriate light baffles will be used throughout to protect not only the chip below but the remaining negatives placed throughout the magazine.

The only other items which pertains to the printing area is the film format mask which is covered in a separate, earlier section.

### 10.5.3 Film Ejection and Magazine Interface

This is the one section of this report which by necessity contains a certain amount of conjecture. Primarily the function is to eject the chip from the platen in its fourth stage, transfer it to a film chip holder, and finally place the film chip holder in a film chip magazine. Unfortunately, both the chip holder magazine and the chip holder are an interface with another piece of equipment and, we do not at the moment, have details on either one. Therefore, in order not to stall this program, we have assumed a configuration for both. We feel that the configuration assumed for the holder should be fairly accurate based upon a five minute visual observation of a similar type holder last August. However, the chip holder magazine is pure conjecture, but nevertheless the basic design should not vary tremendously. We feel it is safe to assume the entire positioning mechanism will stay approximately the same until after the film is placed in the chip holder.

When the platen is positioned in the fourth stage the vacuum is removed and a separate blast of air blows the chip slightly forward and down. The chip drops into a "V" groove at the bottom edge and a solenoid rotates a "V" groove at the top to hold the film from that edge.

A pusher bar attached to a tape drive transports the film chip away from this position and into the chip holder. As the chip is firmly seated in the holder the same bearing continues on pushing both holder and its enclosed chip into the final chip magazine. The chip holders have previously been stored in a drawer behind the turret.

A one rev. shaft serves two functions. First, to individually push forward each individual chip holder until one is secured in the chip load position. Second, to push the last load chip holder back into the magazine after insertion of the holder, making room with the next one to be moved into place. This mechanism is illustrated in Figure 18.

In the upper view in Figure 18 is also illustrated the various vacuum and pressure switches in the appropriate position between the chip holders and the magazine turret. These solenoids control individual pressure on each individual platen and act as control devices for both the liquid gate and air drying system.

## 10.6 CONTROLS AND DISPLAYS

The anticipated control layout is illustrated in Figure 21. This layout should be considered along with Figure 1 which illustrates actual positions and angles of the four separate sections.

For description start in the upper left hand corner and proceed clockwise around the drawing.

The first panel includes all of the functional and error indicator lamps except one. (The go-no-go indicator which will be explained later). The main power switch is also included here. It is set off to one side for insurance against accidentally tripping, and for clear indication.

The right panel displays all of the film footage indicators as well as the mensuration displacements indicators. Zero resets are supplied for resetting both the X and Y indicators. The azimuth has a definite relationship to the film input carriage and, therefore, does not have a zero reset. These zero resets are usable only under manual operation.

The lower panel contains all positioning controls and their required velocity controls. These are established for a right hand operator and are positioned so he can easily observe his manual progress. The panel should be self-explanatory with the exception of the operation switch. This works in conjunction with the joystick. As the joystick is positioned away from the zero position the drive velocity is constantly increased. The range of rates being established by the slew and mensuration control. We have found in previous designs that tkying to return the joystick to zero to stop motion is not always satisfactory. A power drive button on the joystick works well but makes for a large joystick and basically does not supply a natural motion.

By placing an operation switch directly behind the joystick the base of the operator's hand rest on the switch and with the joystick between his fingers he can by depressing his palm or raising it easily control the start and stop of the resultant joystick output.

The panel to the left controls these automatic functinns and those insertions needed after the input film has been positioned. The go-no-go switch is directly near the print button and will represent a go only if all functions indicated on the upper panel are correct and also if the magazine is properly positioned and various other internal functions have been cm completed.

The exposure control buttons are explained under the exposure cntrol section.



10,38

# APPENDIX A

## THE SILICON LIGHT PULSER TECHNIQUE

The following section is offered to the reader for his consideration as an alternate approach to the recommended method that was discussed in Section 6.3. This alternate method will offer a more uniform, universal type of character generation and also allow many more times the machine code information to be stored onto the chip data block.

### A.1 RECORDING OF ALPHANUMERIC CHARACTERS AND DIGITAL DATA

An alternate method of accomplishing a recording of alphabetic and numeric characters and digital data on the film chip is by using a unique method which [redacted] has recently developed. 25X1
This method employs a matrix of silicon diodes operated as light generators. The array of silicon light pulser diodes is a proprietary device of [redacted] and was de- 25X1
veloped by the R&D facility of the [redacted] Semiconductor Division. 25X1

A complementary product line developed using the same manufacturing techniques consists of linear arrays of photodiodes. These devices are used in automatic data readers. Reader design is simplified by an order of magnitude over present designs when recording is performed by an SLP array and reading by a corresponding photodiode array. The reason is the extreme dimensional accuracy of every bit position in both arrays. As a result, significant cost savings can be expected for the automatic reader.

 25X1

## A. 1. 1 Silicon Light Pulser

The Silicon Light Pulser consists of a silicon planar p-n junction which has two output terminals designated the anode and cathode. The device exhibits a voltage/current characteristic similar to that of a standard silicon diode, (see Figure A1). The diode has a high conductance forward voltage region, a low conductance reverse voltage region and a high conductance avalanche region. Normal diodes are usually operated in the two former regions while the Silicon Light Pulser operates in the latter.

When the reverse voltage is raised beyond the avalanche threshold, the diode conducts heavily and a visible light is detected around the region of the junction, (see Figure A2). The fundamental mechanism considered responsible for the emission of light from the avalanching junction is radiative transitions of "hot" charge carriers crossing the junction under the influence of the intense electric field on the order of $10^6$ volts per centimeter existing in the depletion layer of the avalanching junction. These hot carriers have a broad distribution of energy and, therefore, the spectral distribution of the photons emitted on recombination is fairly broad. If transitions occur deep in the bulk of the silicon most of the shortwave length photons are absorbed by the silicon and the emitted light peaks sharply in the red and infrared portions of the spectrum. However, by designing a structure which forces the avalanche breakdown to occur close to the silicon surface, an appreciable amount of light can be generated in the blue-green region of the spectrum and the emitted light will appear as a warm white to the eye. In the optimized structure developed for the photographic recording application, the spectral distribution of the emitted light over the visible region approximates the radiation from a black body having a color temperature of 2500°.

Page Denied

Next 1 Page(s) In Document Denied

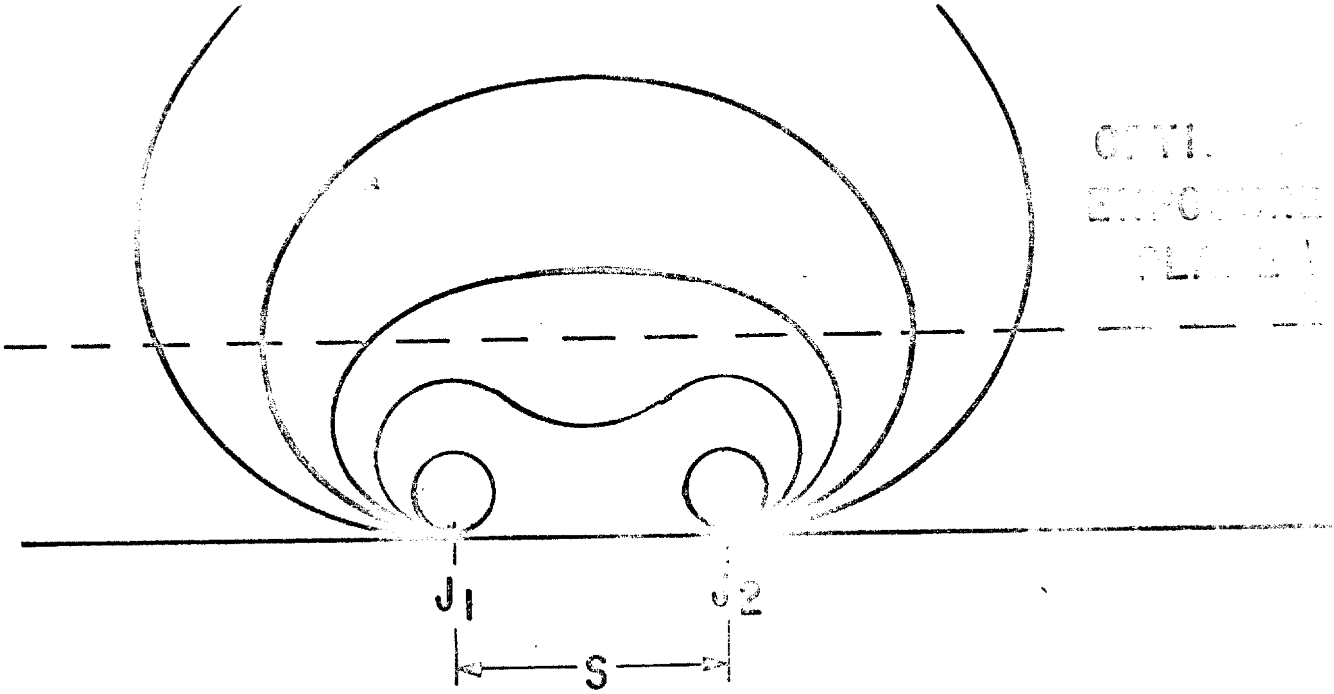



FIGURE A-3. CONTOURS OF CONSTANT ILLUMINATION FOR PARALLEL RECEIVER

 25X1

Microscopically, the light source appears as a line source having a brightness at maximum usable current density levels estimated to be in the range of 5,000 ft.-lamberts. However, this high brightness value must not be confused with a high total light output because the emitting area is extremely small. The light is emitted from a line source and in the matrix array; this line source is actually 6 mils in length and 0.3 microns wide.

In the film recording of digital data, it is desirable that the data bit be recorded as a round dot having a density profile 4.5 mils in diameter at the 50% transmission point. Because the light is emitted from essentially a line source, a means of producing a round, uniformly dense dot of finite area from this source must be devised. The problem is solved by spacing a photographic emulsion at the proper distance from the source and shaping the source to approximate a circle so that the lambertian distribution of lignt from each point in the source combines at the emulsion plane of the recording material to provide the desired density profile. Figure A3 illustrates a series of constant illuminance contours for two spatially separated point sources, indicating how the desired density profile is achieved by spacing the recording emulsion at a given distance from the light source.

A recording light source matrix consists of diffusion isolated p-n junctions, (as shown in Figure A4), fabricated in silicon by the Planar technology and interconnected by standard metal-over-oxide techniques. A single light pulser is energized by making electrical connections to the appropriate row and column of the matrix array. Crossover of the interconnecting busses is accomplished by using the oxide-protected isolation diffusions as the interconnections between the metalized row interconnect bars shown in the figure.

Page Denied

[redacted]

 25X1

## A. 2 RECORDING HEAD

### A. 2. 1 Format

The area available for recording information on the film is 3. 74 inches long and 0. 5 inches high. SLP diodes interconnected to form a matrix will record the various types of data on film as combinations of dots.

The total information content of the display is dependent upon pitch between adjacent SLP devices. The Microdensitometer tracing of an experimental recording as illustrated in Figure A7, justifies a pitch of 0. 009 inches. The recording was achieved on SO-243 (ASA rating 1. 6) developed to a gamma of 2. 3, with an SLP current of 130 milliamperes, an exposure duration of 6 milliseconds, and an optical transmission path of 0. 002 inches. The useful signal as measured by the low interdot density level and the substantial peak to background density difference will insure the capability of a simple automatic readout. The half amplitude dot diameter is 4. 5 mils and yields no interference between adjacent bits.

### A. 2. 2 Alphanumeric

To form alphanumeric characters it is intended to utilize the SLP diodes in a matrix type display. The area of the display is divided into equal size sub-zones. An SLP diode is placed in the center of each zone. If a character were superimposed on the display, some of the sub-zones would be covered by the line forming the character and some would not. To create this character with the matrix, those diodes corresponding to the sub-zones covered are energized. The line describing the character is, therefore, replaced by a series of dots.

 25X1

Figure A5 is a sample of some characters created by a 5 x 6 matrix of diodes whose pitch is 0.018 inches, center to center. While the letters lack much from an artistic viewpoint, they are perfectly legible and lack nothing from an intelligibility standpoint. The selection of a rectangular rather than square matrix is for appearance purposes only. While it is realized that other combinations could be employed to yield more pleasing appearances, it is felt that the 5 x 6 matrix yields a sufficiently pleasing character with a minimum amount of data processing required.

### A.2.3 Machine Readable Code

In addition to the 5 x 6 matrix of diodes for character forming, an additional two rows of diodes will be included for the machine readable code. The machine readable code will be the American Standard Code for Information Interchange with even bit parity and will be written as two separate four bit characters (one per row). The two characters will be combined in the reader to form the eight bit code. The machine readable code word was split into two characters in order to make its geometry compatible with the alphanumeric diode matrix. The total matrix for each character will, therefore, be five (5) columns wide by eight (8) rows high (see Figure A6).

As specified, 56 alphanumeric characters will be printed. Therefore, an array of 8 by 280 diodes will be required. Fore ease of manufacturing the matrix will be broken down into individual chips containing 8 by 40 diodes. Thus, seven chips will be required to print all of the alphanumeric and machine code information.


FIGURE A-5. MICRODENSITOMETER TRACE
EXPOSURE ON ASA 1.6 FILM

ABCD
EFGH
IJKL
MNOP
QRST
UVWX
YZ12
3456
789

FIGURE A-6. ALPHA/NUMERIC CHARACTERS
5X6 MATRIX 0.18 INCH PITCH

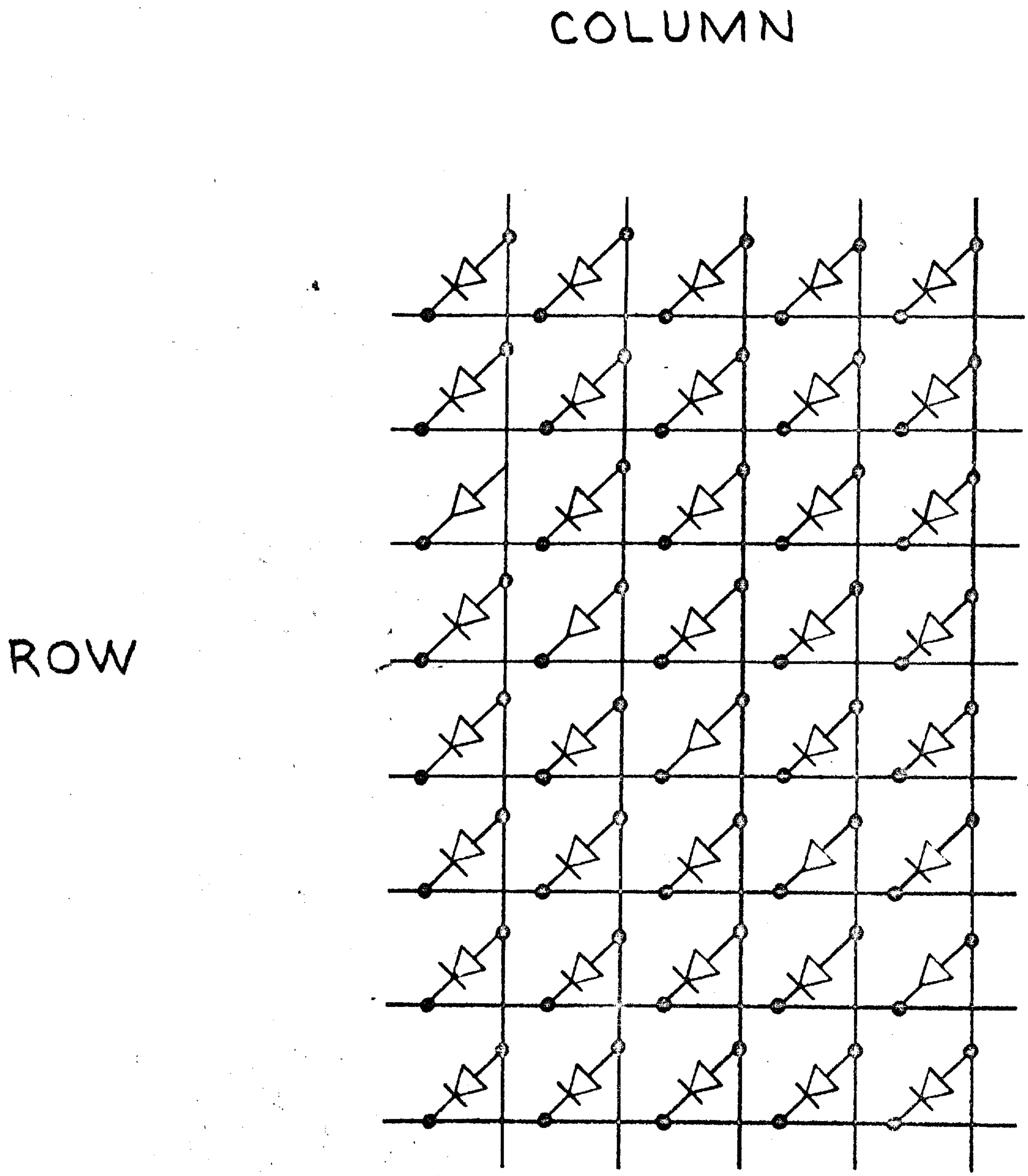



FIGURE A-7 5 X 8 MATRIX SILICON LIGHT PULSERS

### A.2.4 Additional Digital Data

A second 8 x 280 SLP matrix is easily located within the specified format area. This provides the capability to record digital data to the extent of 2,240 binary bits. These would be suitable for automatic readout. The second matrix would be positioned to locate eight bits beneath each column of the alphanumeric data.

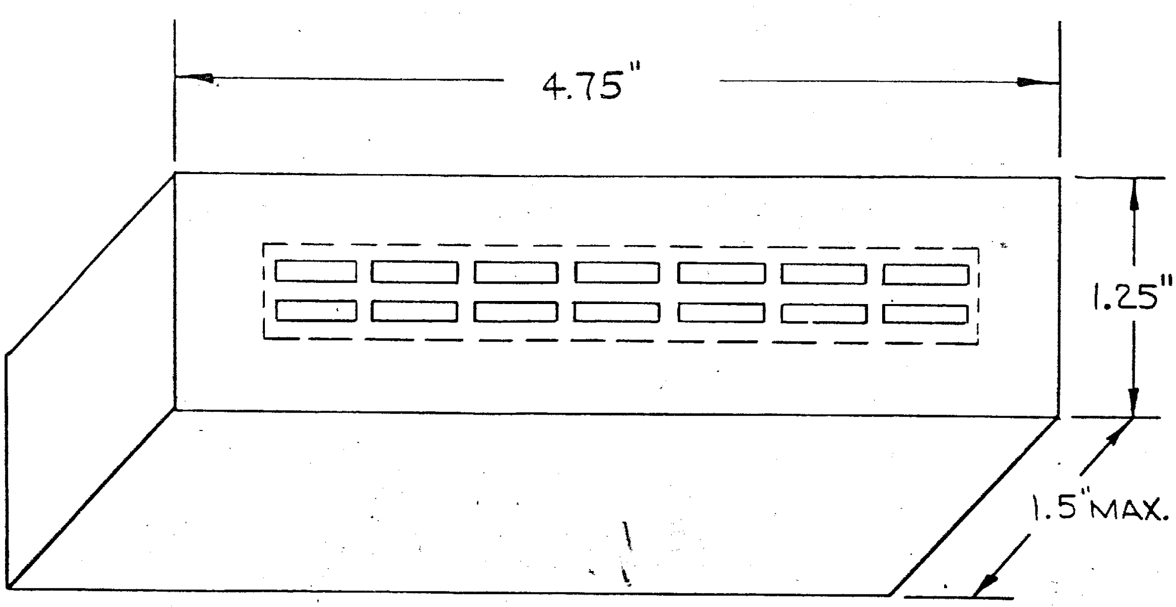
### A.2.5 Record Head

Figure A8 illustrates the solid state record head. The package is compact 1.25 inches wide, 4.75 inches long, and 1.5 inches deep. This package design provides a suitable thermal conductance path away from the light emitting silicon chips, and insures adequate volume for the information of a compact, stress-relieved, output cable from the large number of wires distributed along the edge of the chips.

Fourteen chips each an 8 by 40 SLP diode matrix is located within the required format. The top half of the format will contain the 56 alphanumeric characters and the corresponding machine readable code. The bottom half of the format will contain the additional digital data.

## A.3 DATA PROCESSING

The data input will be supplied by means of eight parallel input lines. A selector gate will be used to separate the data into two storage sites according to its content-alphanumeric or digital. Further processing can proceed independently for each type of data.




NOTE - DOTTED LINE INDICATES .50" x 3.74" FORMAT

FIGURE A-8 PROPOSED RECORD HEAD

As outlined in Section 1.2.3, the recording of alphanumeric information will be performed by a 5 x 8 matrix of SLP diodes. Thirty of the diodes will represent the alphanumeric character and eight the machine readable code. No conversion will be necessary for the machine readable code since the recording will be made in the input code format. However, a conversion from the input code format to a digital code which represents the geometry of the character will be necessary. An analysis of this code reveals that there is no relationship between it and the input code. Therefore, a translation will be required.

Corresponding to each character of alphanumeric data there will be a 5 x 8 array of additional digital data. In other words corresponding to each column of the alphanumeric character there will be eight binary bits of digital data. No conversion will be necessary since the recording will be made in the input code format.

In addition to the translation from the input code to SLP code, it will be necessary during the recording sequence to distribute the data bits to the appropriate SLP devices. The establishment of the record sequence will determine the size of the distribution networks.

A. 3. 1 <u>Selector Gate</u>

Since the processing requirements on the alphanumeric and digital data differ it is desirable to separate them into two buffer registers. This is accomplished using two "AND" gates per input bit and distributing the two outputs to the proper register. The programmer will supply the enabling signals to the "AND" gates distributing the data.

### A. 3. 2 Translator

The input code is the American Standard Code for Information Interchange with the addition of an even parity bit. This code represents each alphanumeric character by an eight bit digital word. The SLP code is the thirty bit digital word describing the geometry of the character. Each bit represents a sub-zone or matrix diode. A logical "1" indicates that the particular sub-zone is to be exposed.

There is no mathematical relationship between the input and SLP codes. This leaves only two forms that the translator can take. One is to store a function table of SLP codes with the corresponding ASCI code as the address. The translation from one code to the other is performed by extracting the result from the table as the character is received. The second is to decode each of the characters as it is received and encode a new word as a function of the decode line which has been activated. For the present application, it has been decided to use the latter process. This decision was based upon the relative amount of equipment required.

Figure A9 is a block diagram of the decoder/encoder. As can be seen, the decoder represents a folded matrix and the encoder is merely a series of OR structures, one per bit.

The character information is received and stored in the 8 bit flip-flop register. The word is then decoded and under command activates the proper OR structures of the encoder. The encode operation is actually performed in the wiring of the OR structures.

### A. 3. 3 Record Sequence

Packaging of the SLP arrays into the specified format area limits the interconnection of the 14, 8 x 40, diode matrices to the

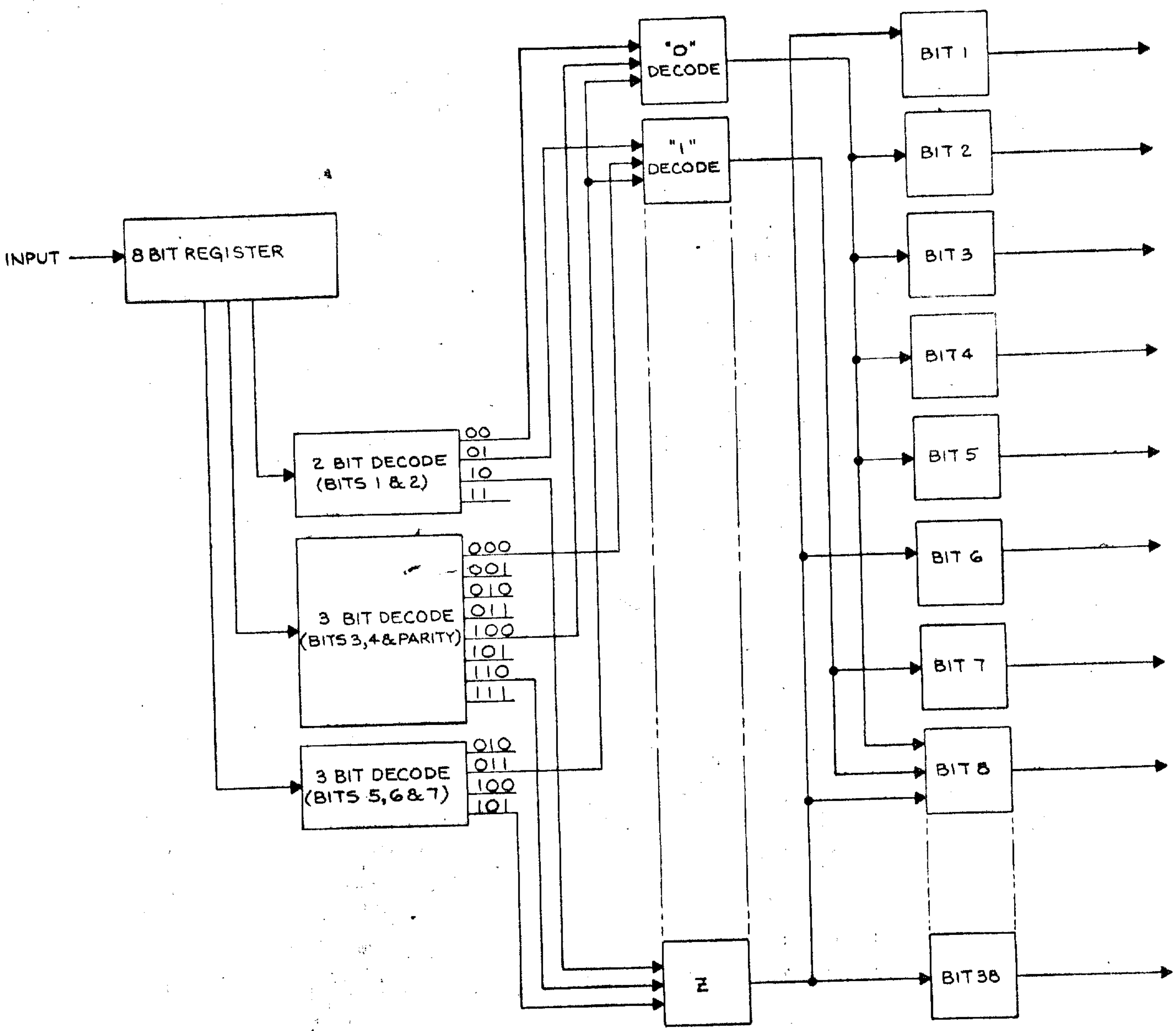



FIGURE A-9. BLOCK DIAGRAM DECODER/ENCODER formation of the 16 x 280 diode matrix. This, in turn, determines the required record sequence since only one column of data can be recorded at a time.

Due to the type of film being used, the recording of each column will require 6 milliseconds. The largest sequence of columns within the 2 second record interval would be 333. The final equipment will serially record 280 columns and the total time consumed will be 1.68 seconds.

The matrix performing the alphanumeric recording will be an 8 by 280 array. The recording sequence will consist of supplying data sets of eight bits to the array rows while enabling the columns sequentially.

The matrix performing the digital recording will operate the same fashion.

A. 3. 4 Distribution Network

The encoder output supplies the alphanumeric character in parallel form as 38 binary bits. For the record sequence defined in 1. 3. 2 the data is desired in the form of 8 row word sequences - rows 1 through 6 consisting of 5 bits and rows 7 and 8 of 4 bits. This is achieved by means of a parallel to serial converter. This consists of a two input "AND" gate for each of the 38 bits. The outputs of the "AND" gates are combined in 8 "OR" gates to form the row words. Timing signals from the Programmer are applied to the "AND" gate to assign each of the input bits the proper time slot.

The application of the binary bit to a particular row while at the same time enabling a particular column allocates a unique array element to that bit.

The digital information is available in parallel form from the input buffer register as eight bits. This is suitable for direct application to the SLP matrix for recording. Simultaneous with each shift of data into the register, a different column of the SLP matrix would be enabled assigning a unique SLP to each input data bit.

## A. 4 SYSTEMS CONFIGURATION

Figure A10 is a block diagram of the Alphanumeric Record System. Information is received in parallel form into two 8 bit registers. Under command of the Programmer the alphanumeric data is decoded, encoded in SLP language and by means of parallel to serial converters formed into row word sequences. Upon command each data bit is fed to the proper matrix row, while the proper matrix column is activated to expose the film. The input registers will store the data for the proper duration during the record sequence.

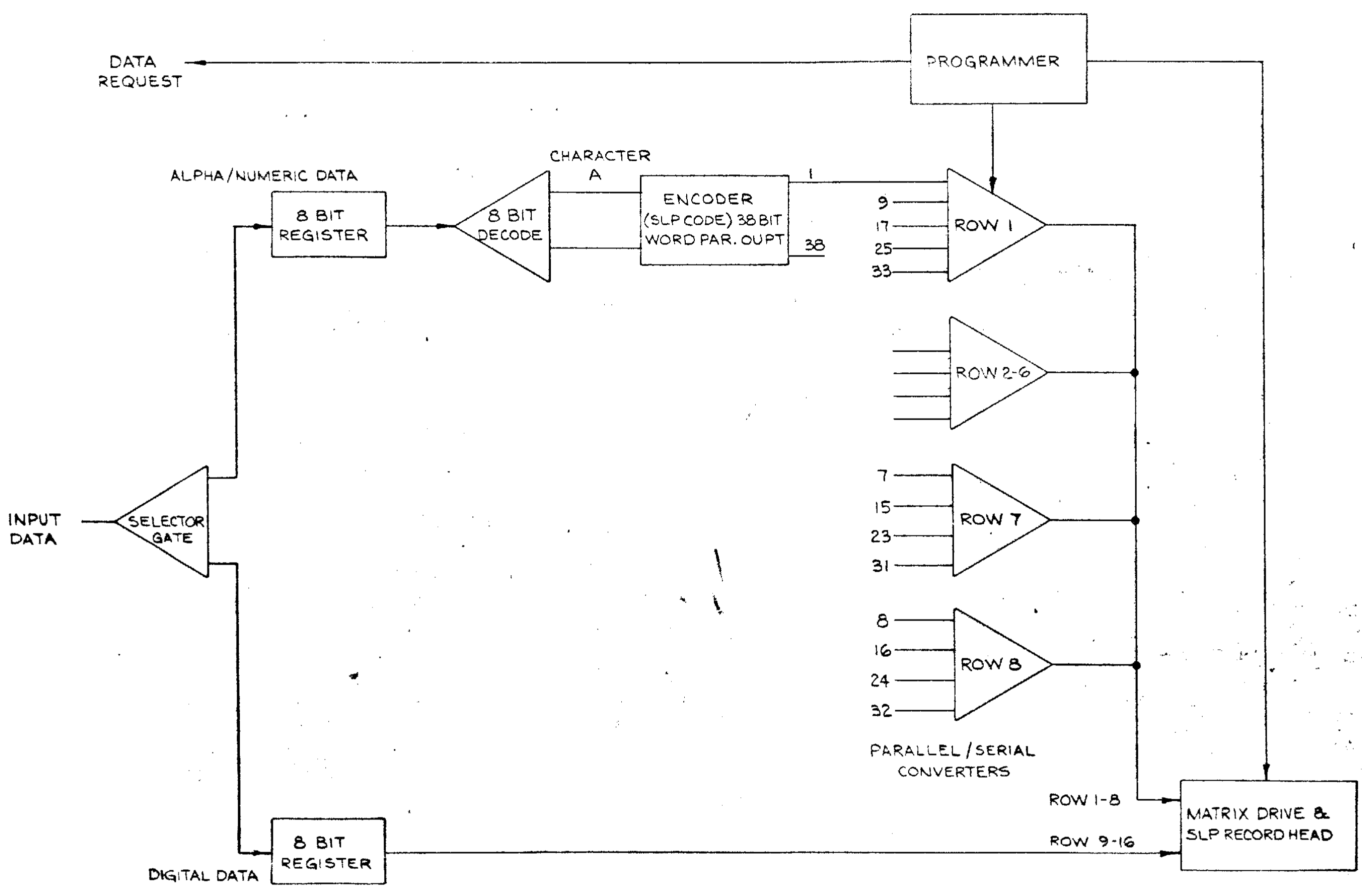



FIGURE A-10 BLOCK DIAGRAM ALPHA/NUMERIC DISPLAY

SECRET
Sanitized Copy Approved for Release 2011/05/03 : CIA-RDP78B04747A000800010009-4